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THE CRANE-FLIES OF NEW YORK

Part II. Biology and Phylogeny

A THESIS

PRESENTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF CORNELL UNIVERSITY FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

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BY

CHARLES PAUL ALEXANDER

Published as Memoir 38 of the Cornell University Agricultural Experiment Station, June, 1920

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KARL WILHELM THEODOR BELING

No sketch of the life of Theodor Beling, the great German student of the immature stages of the Tipuloidea, has ever appeared in English. It was with considerable difficulty that the writer was able to get into communication with relatives and friends of Beling and obtain the data presented herewith.*

Theodor Beling was born at Steterburg, in the Duchy of Brunswick, Germany, on March 26, 1816. He was a son of the district forester. From 1828 to 1834 he attended school at Wolfenbüttel. At Easter, 1834, he began his chosen career as a forester, having served his prescribed apprenticeship of two years with his father at Danndorf. He attended the Royal Saxon Academy at Tharand from 1836 to 1837, and in the following year visited the University of Göttingen to round out his technical training in various branches relating to forestry. Beling's career as a forester extends from Easter, 1834, to October 1, 1888, when he was officially retired with a pension. In April, 1861, he was made Master of the Forest, a position which he held until his retirement.

After his retirement from active public service, Beling long continued his vigorous researches afield and at home. When far advanced in years, he went alone on long trips to seek new stations for plants and to observe animal life in wood and field. He died on December 17, 1898, at Seesen, where much of his finest work was accomplished.

During his lifetime Beling published one hundred and seven articles. The series of three papers which rank him as a pioneer in the field of crane-fly biology were published in the years 1873, 1879, and 1886, respectively. In these papers the histories of sixty-nine species of crane-flies are discussed in detail, and brief notes on five additional species are included. The other published articles of Beling cover a remarkable range of subjects relating directly or indirectly to the science of forestry. His most important researches on the life histories of insects, in addition to those on the Tipuloidea, are on the coleopterous families Parnidae and Elateridae. His published articles are dated between 1850 and 1888, but practically all of his entomological studies were published in the seventies and eighties.

Beling's excellent collection of dried plants, mounted birds, and sections of various woods, and his cabinet of insects — the last-named including the types of several species described by himself and by others — are preserved in the collection of the Natural History Museum at Brunswick. It is understood that the insects in this collection, including the alcoholic larvae and pupae of the Tipuloidea, are still in excellent condition.

* Sincere thanks are here extended to the following persons, who have added materially to the value of this biographical notice:

Landesforstmeister K. Block, son-in-law of Beling, who published in April, 1899 (in *Allgemeinen Forst- und Jagd-Zeitung*), a complete obituary notice relating to his father-in-law, and to whom the writer is indebted for several additional unpublished notes and for the loan of the excellent portrait of Beling reproduced herewith.

J. Meerwartz, Director of the Natural History Museum at Brunswick, who has furnished data concerning the present condition of the collection of the immature stages of the Tipuloidea described by Beling, now preserved in the above-mentioned institution.

William Prindle Alexander and Elsa Müller Alexander, who have rendered valuable service in translating the account of Beling's life.

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THE CRANE-FLIES OF NEW YORK

PART II. BIOLOGY AND PHYLOGENY

THE CRANE-FLIES OF NEW YORK

PART II. BIOLOGY AND PHYLOGENY[1]

CHARLES PAUL ALEXANDER

A preliminary classification of the immature stages of the Tipulidae and related families, suggested to the writer by Dr. J. G. Needham in 1911, is presented in this memoir. But few of the sixty-odd families of Diptera, and comparatively few species of the Tipulidae, have as yet been studied from this viewpoint, and therefore the arrangement herein adopted must be considered as tentative. The majority of the specimens used in the study were reared in New York State, the crane-fly fauna of which is typical of a great area thruout northeastern North America. In 1913, thru the kindness of Dr. Charles D. Woods and Dr. Edith M. Patch, the writer was enabled to continue his investigations in Maine.

It is the writer's purpose to outline the morphological characters available for the classification of the larvae and the pupae, and to give preliminary keys for the separation of the various groups; such keys will, of necessity, require constant revision or complete remodeling with the accession of new life-history material, but it is at least hoped that they may furnish a basis for future investigation. The most important work on the European fauna, that of Theodor Beling (1873 to 1887),[2] is rendered incomplete by the total lack of illustration, the insufficiency of description of the details of the larval head, and the artificial nature of the keys. That this difficulty in using Beling's figureless descriptions is not confined to the writer is shown by the following criticism by one of his fellow-countrymen (Czizek, 1911:7):

"Leider fehlen uns bis jetzt fast vollständig gute Abbildungen der Larven und Puppen, ein fühlbarer Mangel auch in Beling's Abhandlungen, da die genaueste Beschreibung das Bild nie ganz zu ersetzen vermag."

It is intended to include in this paper the following material:

1. Descriptions of all new life-history material available, with notes on the biology and occurrence of the species.

[1] Part I of *The Crane-Flies of New York*, dealing with distribution and taxonomy of the adult flies, was published in 1919 as Memoir 25 of the Cornell University Agricultural Experiment Station.

[2] Dates in parenthesis refer to *Bibliography and References Cited*, page 1019.

2. Brief summaries of published life histories of genera and important species not available for study as specimens and included here to complete the data.

3. Summaries and tabulations of life-history records, larval habitats, economic importance, and related subjects.

4. Keys to the families, tribes, and lesser groups.

The adult flies are not here considered in any detail, since they have been discussed by the writer in an earlier paper (Alexander, 1919 d).

The life histories remaining to be discovered in the Nearctic fauna are still numerous in species, tho few in genera. There are but four or five genera whose life histories when made known may upset the present ideas on arrangement. Until more is known of these missing groups, they must be classified according to the adult structure.

It will be noted that a number of important changes in nomenclature have been adopted in this paper. The system hitherto in vogue, based entirely on the structure of the imagines, was conceived by Osten Sacken and represented the culmination of research on the structure and affinities of the adult flies. A casual survey of the immature stages is sufficient to show the impossibility of many of the groups hitherto generally accepted. The principal modifications adopted in this paper are as follows:

1. The erection of the family Tanyderidae to receive the genera Tanyderus and Protoplasa. These had hitherto been placed with the Ptychopteridae, a group to which they are not closely allied.

2. The removal of the genus Trichocera from the Tipulidae to the Rhyphidae, and the inclusion of the latter family as one of the four existing families of crane-flies.

3. In the Tipulidae, the elimination of four tribes — Antochini, Limnophilini, Dolichopezini, and Ctenophorini — as being based on a conglomeration of forms referable to other tribes or else separated on an insufficient basis. The former tribe Antochini included members which the writer now refers to the Limnobiini (Antocha, Rhamphidia, Dicranoptycha, and other genera) and to the Eriopterini (Teucholabis, Elephantomyia); the Limnophilini are too close to the Hexatomini; and the tipuline forms constitute a very compact group which cannot well be subdivided into tribes.

4. The erection of nineteen subtribes, or divisions, to include lesser groups of genera within the tribes. In the following pages these are

treated in what seems to be their phylogenetic sequence from the generalized to the specialized.

The arrangement of families, subfamilies, and lesser groups may be summarized as follows:

Families	Subfamilies	Tribes	Subtribes	Representative genera
Eoptychopteridae (fossil)				Eoptychoptera
Architipulidae (fossil)				Architipula
Tanyderidae				Tanyderus
				Protoplasa
Ptychopteridae	Ptychopterinae			Ptychoptera
	Bittacomorphinae			Bittacomorpha
				Bittacomorphella
Rhyphidae	Rhyphinae			Rhyphus
	Mycetobiinae			Mycetobia
	Trichocerinae			Trichocera
			Antocharia	Antocha
			Ellipteraria	Elliptera
		Limnobiini	Limnobaria	Limnobia
				Dicranomyia
			Dicranoptycharia	Dicranoptycha
			Rhamphidaria	Rhamphidia
			Ularia	Ula
			Epiphragmaria	Epiphragma
			Pseudolimnophilaria	Pseudolimnophila
	Limnobiinae	Hexatomini	Dactylolabaria	Dactylolabis
			Limnophilaria	Limnophila
				Ulomorpha
			Hexatomaria	Eriocera
				Hexatoma
			Polymeraria	Polymera
Tipulidae		Pediciini	Adelphomyaria	Adelphomyia
			Pedicaria	Pedicia
				Dicranota
		Eriopterini	Eriopteraria	Erioptera
				Ormosia
			Elephantomyaria	Elephantomyia
		Styringomyiini		Styringomyia
	Cylindrotominae			Cylindrotoma
				Phalacrocera
			Dolichopezaria	Dolichopeza
				Brachypremna
	Tipulinae	Tipulini	Ctenophoraria	Ctenophora
				Tanyptera
			Tipularia	Tipula
				Nephrotoma

A permanent series of the immature stages of the species studied has been carefully preserved in the writer's collection, while additional material has been placed in the principal collections of the United States. A series of two hundred and seventy microscope slides showing details of structure of the larvae and the pupae has been prepared, representing some seventy species arranged in forty genera. The typical larvae and pupae (*nepionotypes* and *neanotypes*) have been designated and preserved in alcohol for future reference.

For the most part, the life histories discussed in this paper have not been described hitherto. Besides the reared material, the writer has in his collection a very large number of unknown larvae and pupae, many of them representing interesting and undescribed types. In this paper but three or four of these are considered, and these only because they introduce new features of organization (Eriopterine No. 1, Tipulini No. 1 and No. 2).

A vast amount of work remains to be done on the immature stages of crane-flies. Exact, detailed life histories of individual genera and species are especially needed and the reward for effort will undoubtedly be great. Nothing is known of the tropical and the antipodal faunas, and their life histories will probably be unraveled but slowly, due to the inaccessibility of most of the regions.

The majority of specimens studied in the preparation of this paper were reared by the writer during the past nine years. Many specimens were received from various sources, however, including many of the most desirable life histories, and these are herewith gratefully acknowledged:

Dr. James G. Needham, Ithaca, New York. The extensive collections received from Dr. Needham include the material described in the various Adirondack reports, as well as numerous previously unrecorded specimens. In addition, the writer has accompanied Dr. Needham on many of his field trips in quest of the immature stages of aquatic insects, and has received much encouragement and inspiration from this association.

Charles W. Johnson, Boston, Massachusetts. Immature stages of Aeshnasoma, Elephantomyia, Teucholabis, and other species.

The late Frederick Knab, Washington, D. C. Immature stages of *Rhipidia bryanti*, Elephantomyia, *Epiphragma solatrix*, and other species.

J. A. Hyslop, Hagerstown, Maryland. Longurio (larvae), Oropeza, Gnophomyia.

J. R. Malloch, Urbana, Illinois. *Rhipidia bryanti*.

C. T. Greene, Washington, D. C. Protoplasa (supposition).

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William Lundbeck, Copenhagen, Denmark. Helobia and other species.

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William G. Dietz, Hazleton, Pennsylvania. Notes on larvae of *Dicranomyia macateei* Alex.
Oskar A. Johannsen, Ithaca, New York. *Limnobia fallax*, and other species.
Carl Ilg, Philadelphia, Pennsylvania. Notes on *Rhipidia fidelis*.
O. H. Swezey, Honolulu, Hawaii. Notes on Libnotes and Styringomyia.
H. K. Munro, Pretoria, Transvaal. Notes on Trentepohlia and Styringomyia.
Charles Bruch, La Plata, Argentina. Notes on Trimicra, Helobia, and Epiphragma.
D. B. Young, Albany, New York. Notes on Gnophomyia.
J. T. Lloyd, Cincinnati, Ohio. Eriocera.
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Harold Morrison, Washington, D. C. Holorusia, and *Tipula usitata*.
C. Hamilton Kennedy, Columbus, Ohio. Prionocera and Rhamphidia.
J. Chester Bradley, Ithaca, New York. Longurio.
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Adam Böving, Washington, D. C. Tanyptera; notes on Helobia.

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From Washington, D. C.: C. H. Popenoe, E. R. Kalmbach, Alex. Wetmore, A. T. Speare.
From Lawrence, Kansas: H. B. Hungerford, P. B. Lawson, H. L. Fackler.
From Urbana, Illinois: T. H. Frison, W. P. Flint.

The writer would express his great indebtedness to Dr. Ewald Bergroth, of Jämsä, Finland, for help in determining the derivation of some of the more obscure generic names in the Tipulidae; to Professor T. D. A. Cockerell for notes on the stratigraphy of fossil-bearing beds in many parts of the world; and to Miss Lela G. Gross, assistant editor of the Cornell memoirs, whose critical work on this and the preceding part under this title has been of the greatest value in assuring uniformity and accuracy.

Further acknowledgments of assistance in determining plant and animal associates of crane-flies are made thruout the text. In conclusion, the writer expresses his indebtedness to his wife, Mabel M. Alexander, for her untiring care and assistance in the typing and final preparation of this thesis.

GENERAL CONSIDERATIONS

REPRESENTATIVE CRANE-FLY LIFE HISTORIES

The life histories of but few species of crane-flies have been studied in detail. The very nature of the habitat (mud or earth) required by most species of the family renders it a most difficult operation to rear the species from the egg to the adult and note the various stages, their molts, their habits, and other features. The subfamily Cylindrotominae, the immature stages of which live on the leaves of various higher plants and curiously resemble the caterpillars of certain Lepidoptera, furnishes species whose habits are more readily studied than most others, and as a result the immature stages of this group are better known, perhaps, than those of any other section of the family. Two widely different species have been chosen, and their life histories as they are known at present are here outlined. The first is a species of Eriocera, a powerful, semi-aquatic carnivore; the second is a species of Cylindrotoma, a terrestrial herbivore. In the text which follows, notes on the life activities of various other species are given, but the gaps in the knowledge of this phase of the subject are very considerable and there still remain innumerable interesting facts to be ascertained.

Eriocera longicornis (Walk.)

The common crane-fly *Eriocera longicornis* is widely distributed over the northeastern United States and Canada. Altho the species is local in its distribution, the flies may be found in abundance wherever it does occur. The situations that favor the presence of these flies are large streams or rivers with sand or gravel bottoms and banks. The following notes were taken, partly in Fulton County, New York, along the Sacandaga River, and partly in Tompkins County, along Fall and Cascadilla Creeks. Some of these data have already been published by Alexander and Lloyd (1914:12–18) and by the writer (Alexander, 1915c:149–152).

On May 27, 1914, the adult flies were exceedingly numerous near the village of Northampton, Fulton County. They were present in untold myriads, and at every step they arose in clouds from under foot or from the leaves of chokecherry on which they rested. They sat on the leaves with the head directed away from the observer, ready to take instant flight, and at the first approach of a possible enemy they darted up into

the air and far overhead. A few were in copulation on the leaves, but from observations made later it seems probable that mating begins in the air and the united pair seek a support later on. Toward twilight the flies may be found in great numbers in company with many kinds of caddice flies and may flies. The swarms vary in numbers from about fifty individuals to those including many thousands. Some of the larger of these swarms cover a vertical height of at least fifty feet, the lower individuals being about fifteen feet above the water. When danger approaches, the swarm either mounts into the air overhead or retreats before the breeze, never advancing nor moving sidewise.

Out over the land in the smaller swarms, copulation was observed several times. The males in the swarm dart swiftly at the females and seize them almost instantly. They then usually leave the swarm and go sailing away, the male above doing the flying, the smaller female hanging limply beneath. The antennae of the male at this time are directed straight ahead and are slightly divergent, the legs hang downward, the wings vibrate rapidly. The female hangs downward with the legs trailing limply beneath, the wings nearly horizontal and motionless. The dead weight of the female continually pulls the male toward the water, and often both fall into the river. As a rule, copulation ends before the male is exhausted. The male opens his forceps and the female drops straight downward for a foot or so, quite like a parachute released from a balloon. If the pair are near the surface at the time of separation, the released female drops into the water. The male darts upward again and back into the swarm. The female slowly flies away, usually upstream but sometimes downstream, presumably to lay her eggs. She does not stop for swarms that she may encounter, and may even make a wide detour in order to avoid them. In a very few cases the female is the active partner and succeeds in pulling the male where she wills altho she is much smaller. No matings were observed during the hours of sunlight, and it was only at twilight or just after sunset that mating took place. Often a second male will seize a female already in copula and the three will come tumbling down into the water together. One such pairing of three individuals came down, and when they were about a foot above a board in the water the male in copulation dropped the other two. These rested for a moment, and then the remaining male attempted to engage the female in copulation. She resisted but finally he managed to seize her

with his forceps. Then he attempted to fly away, but she seized hold of the board with all her feet and he was unable to disengage her. This seems to indicate that the normal place for copulation is in the air.

The motions of the insects in the swarm were very rapid, almost like those of bees, and the sound produced was at a very low pitch, much lower than that made by Culex. The movements are on a horizontal plane, each individual flying mostly in the path of a figure 8, sometimes slowly and at other times much more rapidly.

Many specimens were seen dipping down into the water, as tho engaged in laying eggs. All of the few specimens captured proved to be males, but why this sex should go thru these motions is not clear to the writer. This action has been observed several times in various species of crane-flies. It is very probable that the female lays her eggs in the water in this manner.

The eggs are pale white or brown, not heavily chitinized as are those of Hexatoma but with the chorion feebly sculptured. They vary in number from 892 to 1034, with an average of 952. They are small, about the same size as those of Hexatoma. The ovaries almost completely fill the abdominal cavity, and the eggs are arranged in the ovaries like bananas on a stalk, with numerous pale nurse-cells in between.

The larval life is passed in streams, usually under rocks. The winter is spent in the larval condition, but the larvae do not attain full size until the following spring. At this time they come to the land and live in the sand and gravel along the banks of the streams. By the alternate extension and contraction of the body and the inflation of the penultimate segment of the abdomen at the moment of extension, the larvae are capable of inflating this segment into an enormous globular structure which serves as an aid to progression thru the soil. The food of the larvae consists largely of animal matter, and often large species, such as chironomid larvae, are swallowed whole. The almost total lack of chitinization of the mental region allows for great distension of this part of the body. The powerful mandibles and the retrorsely roughened esophagus serve the function of both holding the prey and preventing its ejection when once swallowed. Considerable gravel and particles of vegetable tissue are also found in the proventricular region.

When ready to transform to the pupal condition, the larva becomes sluggish. After molting the last larval skin, the pupa is disclosed, pale

yellowish white and very callow. The pupa forms burrows in the loose gravel, these being vertical, or, more often, a little oblique. The diameter of the burrow is a little greater than that of the pupa. The length varies, the burrow for a young pupa being a mere chamber inclosing the individual and located from one-half to one inch below the surface. As the pupa becomes older, by a bobbing up-and-down motion it lengthens the burrow upward until finally it penetrates the surface layer and forms a small shot-like opening. Here the pupa rests, often bobbing up and down with a rhythmic motion, but ducking down into the burrow when danger threatens. The length of the burrow is rarely more, but usually less, than twice the length of the pupa. A few of the pupae seem to be inclosed in a very delicate silken tube and the salivary glands seem to be well adapted for the purpose of forming silk; but the great majority of the pupae are entirely naked. The indoor pupal period varies from one hundred and seventy to one hundred and seventy-three hours, or a little more than seven days. The outdoor pupal period, however, is undoubtedly longer, unless the weather is very warm.

The emergence of the adults usually takes place during the late hours of the morning, the greatest number emerging between ten o'clock and noon. When ready to emerge, the pupa pushes part of its body out of the earth, the posterior two-thirds or half remaining attached to the soil. If it projects farther than this, its transformation seems to be a very difficult operation. The pupa bends backward and forward constantly, flexing the body dorso-ventrally. This motion appears to exhaust it, since it frequently rests. The skin splits lengthwise up the mesonotum and the adult emerges. The male has difficulty in extricating its very long antennae from their sheaths. The tips of the fore femora are placed underneath the sharp spines of the flagellum, and by raising the legs the insect pulls the antennae slightly outward. These spines are regularly spaced, and, since both fore legs work in unison, the spines function as cogs and the whole antenna is gradually forced from the pupal sheath. The body is carried very straight and stiff during the operation, and the abdomen is very long and pale. The drawing out of the extreme tips of the antennae is usually accomplished by the insect flexing its whole body backward. When the antennae are freed, the insect walks a few steps from the cast skin, withdrawing its abdomen from the case. (The emergence of *E. spinosa* is shown in Plate XII, 1.) A drop of nearly colorless liquid is excreted

from the body at this time. The teneral adult then waits quietly until it gains more strength and color. This condition of the insect is the most dangerous period of its existence, since it is defenseless against all enemies.

The insects are associated in the gravel with ground beetles of the genera Omophron, Schizogenius, Dyschirius, Bembidion, Tachistodes; with click beetles of the genus Cryptohypnus; and with rove beetles, of which Paederus, Lathrobium, and Gastrolobium are the commonest forms. In addition, numbers of larvae of Tabanidae, Leptidae (Atherix), *Eriocera spinosa*, *E. fultonensis*, *E. cinerea*, and *Erioptera armata* were found. Natural enemies of the pupae and the teneral imagines are the medium-sized black lycosid spiders, which preyed in numbers on the weak, uncolored adults. Dozens of these spiders were noticed with individuals of the crane-flies in their grasp. When alarmed they would run rapidly away, but only in exceptional cases would they release their victims. A few spiders of other families, notably the Attidae, were found with Eriocerae. Dragon-flies appear to be the most serious enemies of the active adults. *Helocordulia uhleri* (Selys) has been observed capturing the crane-flies by darting back and forth thru the swarms of individuals.

Cylindrotoma splendens Doane

The life history of the species *Cylindrotoma splendens* has been worked out in considerable detail by Dr. A. E. Cameron, from material obtained near Westholme, Vancouver Island, British Columbia, in late April, 1917. The following account is abstracted from Cameron's detailed paper (1918) on this interesting crane-fly:

The adults first appear on the wing about the middle of May. Without food they do not live longer than five or six days, but in breeding cages, where they were supplied with food in the nature of a sugar solution, they lived as long as from seven to nine days. In nature the adults were found on the wing during a period of about three weeks.

Soon after emergence the adults begin to copulate, and one male may have intercourse with more than one female. Copulation often takes place in a vertical position, the female above, the male below, with the tips of the abdomens interlocked. At times the female was noted hanging to the roof of the breeding cages, with the male suspended head downward, his body at an angle of 90° to that of the female, and his legs unsupported. If disturbed, the female may walk off, dragging her mate after her, or she may take flight, bearing the male with her. In nature the act of copulation is generally undertaken in the deep shade of the large leaves of the insect's food plants, the sexes resting on the under surface of the leaves or on the stems. Copulation may last but a few minutes or may require several hours.

The eggs are of a dull glistening white, elongate-oval in shape. Under natural conditions they are almost invariably found on the under surface of the leaves of the food plant *Trautvetteria grandis* Nuttall (Ranunculaceae), inserted beneath the incised epidermis. They

are usually deposited in series along and just within the margin of the serrate, palmately-lobed leaf. They are found in groups of one or more, all arranged parallel to one another and with their long axes perpendicular, or nearly so, to the margin of the leaf. The eggs are only partly hidden beneath the epidermis, being exposed dorsally, the margins of the slit overlapping the egg laterally and, to a lesser degree, both anteriorly and posteriorly. This arrangement of the eggs in series gives to the leaf margin a somewhat beaded appearance. When the eggs are older, the leaf margin turns brown and the presence of the eggs is readily detected. In ovipositing, the female rests on the under side of the leaf, with the tip of the abdomen directed toward the leaf edge. The abdomen is slightly flexed ventrally, and the margin of the leaf is held between the bifurcated valves of the ovipositor, which is applied to the upper surface of the leaf, while the paired cutting valves, with their blades, are applied against the under surface. These blades are then moved to and fro, cutting a slit in the epidermis. The eggs are then deposited. In no case do the eggs actually touch one another on the leaf. In the breeding cages females lay their eggs indiscriminately on both the upper and the lower surface of the leaves. In some cases, when a leaf has been eaten earlier in the season by larvae, the female will deposit her eggs along the ragged edge of this damaged part.

The indoor duration of the egg stage is from fourteen to eighteen days, but in the field as long a period as three weeks may be required. When first deposited the egg is translucent, grayish white, and spindle-shaped, with the chorion unornamented, and measures on an average 0.84 by 0.303 millimeter.

The larva requires about three hours to emerge from the egg. The chorion of the egg splits longitudinally down the mid-dorsal line, the slit extending almost half the length of the egg. In emerging, the almost transparent, grayish white larva utilizes the body tubercles as levers in freeing itself from the eggshell. As soon as it is freed from the shell, the newly hatched larva begins to feed on the leaf tissue of the host plant.

The first-stage larvae are grayish white in color, are translucent, and measure 1.19 by 0.37 millimeter in size. They feed on both the upper and the lower surface of the leaf, burrowing thru the epidermal layer with their mandibles and feeding on the parenchymatous tissue within. The young larvae are very sluggish and are not readily disturbed when feeding, the mandibles being firmly embedded in the leaf tissue. While engaged in feeding they assume various positions on the leaf surface. At the end of nine days the larvae have increased in length to 5.84 millimeters, and show all the characteristic behavior of the full-grown larvae. Growth is very slow, and before the first molt the larvae become covered with particles of their excrement, which adheres readily to the skin. The first larval molt occurs after a period of from eighteen to twenty-one days; in some cases, however, it does not occur until five or six weeks have elapsed.

The second-stage larvae gradually assume a leaf-green color as they continue to feed. Toward the end of July, coincident with the dying-off of their food plant, the larvae, which have now reached a length of from 8.32 to 9 millimeters, become quiescent and cease to feed. Feeding and movement gradually cease completely and the larvae remain clinging motionless to the leaves. As the leaves wither, the larvae drop off, and, in some cases, attach themselves to the stems; under natural conditions, however, they usually fall among the dead leaves on the ground and under these they pass the winter in a dormant condition. Many of these larvae match the brown color of the dead leaves, but some of them retain their leaf-green tint.

The overwintering larvae first show signs of activity in March of the following spring, when *Trautvetteria grandis* sends up its new shoots. Growth then proceeds rapidly until pupation in the middle of May. There seems to be one molt before hibernation and two after, the last being the casting of the larval skin, previous to pupation. The fully grown larvae measure 17 millimeters. They are invariably found on the upper surface of the leaf, and in the spring are actively engaged in feeding. On a fresh leaf the larvae usually begin by skeletonizing it, leaving the lower epidermis intact. Later on, however, large holes may be eaten completely thru the leaf. The fully grown larvae, and to a somewhat lesser degree the younger larvae, progress by a looping motion, which may be aptly compared to that

of the measuring worms (Geometridae), progression being accomplished by the aid of the mandibles and the ventral tubercles, or pseudopodia. In a quiescent condition the thoracic region of the body has a noticeable humped appearance. The fully grown larvae are very sluggish and inactive. When disturbed they relax their hold on the leaf surface and fall to the ground. Altho several hundred adults were reared, not a single parasite was discovered.

Before pupation the larva attaches itself firmly to the surface of the leaf or to the leaf petiole, by means of its anal pseudopodia. The skin splits transversely behind but is only partially sloughed off. The head, the thorax, and the first four abdominal segments of the pupa are exposed, but the apex of the abdomen remains encased in the larval skin, the terminal part of which, collapsed and wrinkled, is attached to the leaf surface. Pupation may take place on either the upper or the lower surface, but it occurs oftener on the former. If pupation takes place on the petiole, it is generally at the axil. In the breeding cages the duration of the pupal period was found to vary from six to ten days.

When the adult first emerges it is of a pale green color, which is gradually replaced by the black and yellow of the fully colored insect. From one and one-half to two hours are required for the adult to emerge. After emergence is completed, the fly rests for a short period until the cuticle hardens and the wings expand. It seems that the adherence of the larval skin to the pupa is necessary for the emergence of the adult, at least in many cases. There appears to be a large disproportion of females over males, this sometimes being as high as five to one. Since a single male may copulate with several females, this disproportion is not so serious as it appears at first sight.

LIFE ACTIVITIES OF CRANE-FLIES

The adult

Emergence.— Emergence from the pupal hull may require but a few seconds (as described for Gnophomyia by Hyslop *in litt.*, the whole operation requiring but eight seconds), or it may take several hours. The emergence of the strictly aquatic genus Antocha has not been observed, but it must be practically instantaneous as in Blepharocera and the lotic caddice flies.

Mating.— In several widely different species, the females as they emerge from the pupal hulls are at once seized in copulation by the males altho they are still callow and uncolored. Mik (1882b:40, and 1886a) discusses this curious condition in considerable detail. In all the cases that are known to the writer — *Dicranomyia trinotata*, *Discobola caesarea*, and *Cylindrotoma distinctissima* (Mik, 1886a, the last-named also cited by Mik, 1882 b), *Liogma glabrata* (Müggenberg, 1901), *Tipula rufina* (Giard, 1895), and *Tipula ultima* (Caudell, 1913) — the abdomen of the female is elongate, flabby, and nearly colorless. In *Dicranomyia trinotata* the females scarcely have time to remove their legs from the pupal sheaths before they are seized in copulation. In other cases the males emerge before the females and wait beside the pupae for the emergence of their mates, when they at once seize them in copula. In most species of Tipula the males, when seeking the females, progress by a fluttering

motion, partly flying and partly walking, over the ground or up the trunks of trees. This habit is discussed under the account of *Tipula taughannock* (p. 1013), and has been observed in other woodland-inhabiting species of this genus — as *T. macrolabis*, *T. fuliginosa*, *T. fragilis*, and others. In *T. fragilis*, when a male comes upon a pair already in copula he passes on without interrupting them. Somewhat similar mating habits are found in some species of Dicranomyia (*D. trinotata*, *D. badia*, and *D. simulans*), Discobola, Antocha, Chionea, *Dactylolabis montana*, some Pediciini as Dicranota, and the Cylindrotominae.

Many crane-flies have developed swarming habits for the purpose of mating, these including representatives of most of the tribes of the Limnobiinae and a few tipuline forms. *Dicranomyia morioides* was observed by Needham (1908a:204) swarming in vast numbers near Ithaca, New York, but here the swarms consisted only of males. Likewise, *Erioptera armata* (Needham, 1908a:206) was found swarming near Lake Forest, Illinois; but, out of several hundred individuals captured, all except three were males. The writer has observed swarming in numerous species of Ormosia, Molophilus, Erioptera, Gonomyia, Rhabdomastix, Limnophila, Ula, Epiphragma, Eriocera, Dicranota, Rhaphidolabis, Trichocera, and other genera, and here, too, the males were always predominant. The specific data may be consulted under these various headings. The males of Dicranota swarm in rather large numbers preliminary to searching for the females, which rest quietly on the branches of neighboring shrubbery. *Limnophila ultima*, as noted at Gloversville, New York, on September 7, 1916, was swarming at half past six o'clock in the evening. The swarms here consisted of from fifty to sixty individuals and took place from ten to eighteen feet above the earth. Mating took place frequently in the air, and as soon as a pair were in copula they flew away to some point to rest, many pairs being observed hanging on a clothesline a few feet away. There were three distinct swarms, which showed little tendency to fuse altho their flight area was very close. The vast swarms of *Eriocera longicornis* and of Trichocera are mentioned or discussed elsewhere in this paper. When pairs are in copula, they readily take flight, still united, the female usually trailing the male after her; altho in a few groups, in which the male is the larger individual of the two, the situation is the opposite. Brachypremna, the familiar " weaver " of the Southern States, has a very remarkable vertical dance of several

feet in shady spots, and has been aptly termed by Johnson (1907–12 [1909]:123) "the king of the dancing tipulids." Doubtless many interesting facts remain to be discovered concerning the dances of the tropical species of Brachypremna, Tanypremna, and Megistocera.

Dancing.— The dances of *Thrypticomyia saltens* (Dol.) should be mentioned at this point. According to Doleschall (1857), Jacobson (De Meijere, 1911:22–23), and others, this species is common in Java in shady places thruout the year. The insects have the habit of clinging to spider webs by means of the fore feet, or, if a fore foot is lacking, one of the middle legs is used. Often twenty or more of these flies are seen hanging close beside one another on a horizontally spun web, all seesawing rapidly up and down and at the same time swaying to and fro, sometimes rhythmically, sometimes not. This ludicrous tight-rope dance is continued for a long time. Somewhat similar habits have been described for *Trentepohlia pennipes*, *Rhamphidia venustissima* Alex., and other species with white tarsi.

Bobbing.— Species of Dicranomyia and Geranomyia, as well as a few other crane-flies, have the curious habit of bobbing up and down while resting, the long, slender legs acting as springs. The species of the latter genus practice this same oscillating movement while resting on a head of flowers and feeding. H. K. Munro has recorded this bobbing habit in a species of Trentepohlia (p. 943).

Resting habits.— When at rest crane-flies assume various positions which are often fairly characteristic. Many species (Erioptera, Molophilus, and some Dicranomyia) resemble spiders when flattened against a tree trunk or some other vertical support. Styringomyia resembles a bit of cobweb, the fore and middle legs stretched out in front, the hind legs directed backward. In a position of rest the tipuline forms generally hold their wings outspread or divaricate, exceptions being in the genera Longurio, Oropeza, and others, and in a few species of Tipula, as *T. arctica* and the woodland-inhabiting species of the *marmorata* group (*T. fragilis* and *T. ignobilis*). The limnobiine forms usually fold the wings incumbent over the abdomen, but here again exceptions are found in Pedicia, *Limnophila toxoneura*, and other species, which normally rest with the wings outspread. Oropeza hangs to the roofs of bridges, culverts, and similar places, with only the fore legs attached to the support, the middle legs divergent, the posterior legs hanging loosely behind. The apparently

closely allied Dolichopeza, on the contrary, has the four anterior legs on the support, the hind legs dangling, the wings divaricate. Many of these species — as Oropeza, Dolichopeza, *Dicranomyia badia*, and exotic species of the genera Thrypticomyia and Trentepohlia — habitually rest on spider webs (page 982; also, Knab, 1912). During heavy rains, crane-flies rest on the lower side of the broad leaves of deciduous trees or hide beneath loose flakes of bark.

Feeding.— The adult flies feed but little, the majority of the species whose habits are at all known merely lapping nectar from open flowers. Knuth (1909:579) and Wahlgren (1917) record the plants frequented by a number of European Tipulinae as well as by Ptychoptera. These species are found on Umbelliferae (Aegopodium, Anthriscus, Heracleum, Carum, Anethum, and other genera), on Rosaceae (Spiraea, Rubus, and other genera), and on a few other plants. A few of the local Limnobiinae have the rostrum very greatly elongated — an obvious adaptation for sucking the nectar from tubular flowers. The species of Geranomyia feed on various composite, umbelliferous, and lauraceous flowers. Toxorhina frequents composite, rhamnaceous, apocynaceous, and ericaceous plants. The exact plants frequented are discussed under the descriptions of the respective genera.

Oviposition.— The females lay their eggs in the habitat frequented by the larvae. In the case of aquatic forms — as Antocha, Hexatoma, Eriocera, and other genera — the eggs are deposited in dipping down to the water surface, one or more eggs being deposited at each descent. Forms that live in mud or moist earth lay their eggs in these situations. Many species with acute ovipositors insert the eggs carefully into the soil or other substance. The oviposition of *Limnophila* (*Eutonia*) *alleni* as noted by the writer may be regarded as typical of this class of species:

> Observations made at Gloversville, New York, June 28, 1916. A female was noted ovipositing in low, wet spots along a small woodland stream. She flew about slowly and silently, just skimming the ground, until a place suitable for egg-laying was found. She finally chose a much-decayed log and the eggs were driven home securely by the acicular tergal valves of the ovipositor. Much effort is expended to place the eggs firmly and the rate of oviposition is not more than eight or ten a minute, the female often pausing to rest for several seconds. While thus engaged, the fly is entirely unconcerned with other agencies and may be picked up by hand.

The females of most crane-flies usually live but a short time after egg-laying is completed. Indeed, the entire duration of life of the adult crane-flies is probably but a few weeks at the most.

The specialized methods of oviposition in the Cylindrotominae have already been discussed on page 709 under the account of *Cylindrotoma splendens*. The species of Tipula and other genera the females of which have blunt valves to the ovipositor (Styringomyia, Macromastix, and others), all probably scatter their eggs promiscuously or else have a specialized method of egg-laying. Similarly, the species of Tipula of the *arctica* group, in which the dorsal valves of the ovipositor are very large, placed horizontally, and with the margin finely serrated, undoubtedly have a peculiar method of oviposition, but this has not yet been observed.

The egg

The number of eggs laid by crane-flies varies from about forty-five in Styringomyia to some two thousand in the larger species of Eriocera. The following table indicates the general range in the group:

Species	Number of eggs laid			Reference
	Maximum	Minimum	Average	
Ptychoptera albimana	587	520	554	Topsent, 1914–16
Styringomyia didyma	45	.....	45	Terry ms.
Eriocera longicornis	1,034	872	952	Alexander ms.
spinosa	2,061	1,824	1,942	Alexander ms.
Hexatoma megacera	372	316	347	Alexander, 1915 c
Phalacrocera replicata	60	.....	60	Miall and Shelford 1897
Liogma glabrata	60	.....	60	Müggenberg, 1901
Ctenophora angustipennis	400	200	300	Lovett, 1915
Tipula cunctans	.....	.....	300	Hyslop, 1910
bicornis	297	282	289	Webster, 1893 b
tephrocephala	255	.....	255	Webster, 1893 b
angustipennis	602	.....	602	Hyslop, 1910
collaris	329	.....	329	Alexander ms.
dejecta	366	251	309	Alexander ms.
oleracea	600	.....	600	Del Guercio, 1914

The eggs are in most cases elongate with the ends narrowed and rounded, or, in other words, spindle-shaped. The chorion in the species of Tipula, Hexatoma, and other genera is blackened and in some cases more or less sculptured. In *Ctenophora angustipennis* (Lovett, 1915) the egg is ebony black with deep purple reflection, elongate-oval, uniform, without pits or ridges, and measuring from 1.26 to 1.4 millimeters by 0.375 millimeter

In *Tipula bicornis* (Webster, 1893 b) the egg is 0.8 millimeter long by 0.3 to 0.4 millimeter in diameter, elongate-ovoid, with one side deeply concave, the surface highly polished. The egg of *Nephrotoma ferruginea* is smaller, with five distinct grooves. The egg of *Tipula glacialis* (Pokorny, 1887:53) is described as being 1.2 millimeters long and only 0.3 millimeter in diameter, cylindrical, the two ends equally rounded, the surface smooth, shiny black, with faint steel-blue or purplish red reflections. In many other genera of Tipulidae, especially the smaller forms, the eggs are soft and whitish or nearly hyaline. In a few species the eggs take on a decided green or greenish tinge. The egg of *Cylindrotoma splendens* is described elsewhere in this paper (page 709). The egg of *Ptychoptera albimana*, as described by Topsent (1914–16), measures 0.825 by 0.264 millimeter, and is pale yellow, slightly arcuated, and with the surface curiously ornamented.

The larva

As a rule, the larvae live in the haunts where the eggs are laid. The duration of the larval stage varies from about a month in Styringomyia (larva and pupa together, thirty-seven days — Terry ms.) to the greater part of a year in most crane-flies. Many of the smaller species of Erioptera, Ormosia, Rhaphidolabis, and other genera are on the wing in the spring and again in the fall, and with little doubt are double-brooded. This would make the larval existence but a few months, but still probably longer than the other stages taken together. This problem of double broods should be worked out carefully. It often appears that there are two broods, when in reality there may be two developing generations, each passing the winter as larvae, but one attaining its growth much more slowly in the spring and summer and not maturing until late summer. Phalacrocera and *Cylindrotoma splendens* spend about eleven months in the larval stage (Bengtsson 1897, and Cameron 1918), while *Tipula paludosa* spends nine months in that stage (Rennie, 1917). It is probable that nearly all crane-flies in the North Temperate Zone winter normally as larvae. The growth during summer, fall, and winter is very slight, but in the spring it is greatly accelerated and in a month the larva may attain its full growth. Larvae of *Tipula ignobilis* taken at Ithaca, New York, on April 23, 1917, measured only 6.5 millimeters in length; on May 19 they had attained their full growth of 18 millimeters and were ready to pupate. *Cylindrotoma splendens* spends the winter as a larva,

9 millimeters in length, but grows rapidly during the spring, attaining its full size (17 millimeters) in two months of growth. *Liogma glabrat* spends the winter as a very small larva, but in the spring its growth is greatly accelerated.

The haunts in which the larvae of crane-flies occur are exceedingly varied. In the case of single large genera, such as Dicranomyia and Tipula, the species range from those that are almost strictly aquatic to others that are entirely terrestrial, living in decaying wood or even mining in the leaves of plants.

The transition between strictly aquatic and terrestrial forms is very gradual, as was pointed out by Miall (1895:11) some years ago when he wrote:

> How did insects ever come to seek the water, seeing that their mode of respiration is primarily adapted to another element? We can see almost all the steps of the adaptation on the shores of our rivers, lakes and seas. We can see dipterous larvae which, like the "leather jacket" (the larva of the daddy-long-legs), burrow in the ground for their vegetable food, and devour the roots of grasses. Other larvae of the same family (Tipulidae) prefer moist earth in the neighborhood of streams. Others again live immersed in water, or mud saturated with water, though they come to the surface at times and push their tails, which carry the spiracles, into the air. Some few have become so completely aquatic that they seldom, if ever, come to the surface, and all their supply of oxygen is obtained from the water.

The culmination of this latter condition is reached in forms such as Antocha and related genera and species. Crampton (1919:100) has made similar observations on the subject.

The haunts of the larvae of crane-flies are best shown by the following table, in which the various species are arranged according to habitat, from the strictly aquatic to the various terrestrial forms:

Habitat	Species
Strictly aquatic, in silken cases	Antocha
In very rapid water (lotic) on or in submerged mosses (hygropetric association)	*Dicranomyia simulans*, Pedicia, Triogma, Tipuline No. 1, and others
Aquatic, on submerged plants	Phalacrocera, Triogma
Semi-aquatic (part of life spent in water, but pupation taking place on land)	*Dicranomyia simulans*, Eriocera, Hexatoma, Aeshnasoma, Longurio, *Tipula abdominalis*, *T. caloptera*, *T. bella*, and others
On cliffs and wooden walls, usually in silken cases covered by water	*Dicranomyia simulans*, Geranomyia, Elliptera, Dactylolabis, and others
In cold springs	Pedicia, Thaumastoptera

Habitat	Species
In stagnant water in the axils of bromeliaceous and other plants	Trentepohlia, *Gnophomyia rufa*
Amphibious in decaying wood	Protoplasa (supposition), Epiphragma
In mud or sand:	
a. In open swamps	Bittacomorpha, Ptychoptera, Rhamphidia, *Erioptera septemtrionis*, *E. chlorophylla*, *E. vespertina*, *Limnophila adusta*, *L. macrocera*, *Pilaria recondita*, *P. tenuipes*, *P. quadrata*, *Tricyphona inconstans*, Prionocera, *Tipula dejecta*, *T. sayi*, *T. tricolor*, and others
b. In shaded woods	Bittacomorphella, *Ormosia innocens*, *Erioptera megophthalma*, *Molophilus hirtipennis*, Ulomorpha, Dicranophragma, Penthoptera, *Tipula cayuga*, and others
c. Along the margins of streams and other bodies of water	*Limnobia fallax*, *Erioptera* (*Hoplolabis*) *armata*, Trimicra, *Gonomyia* (*Leiponeura*) *alexanderi*, *G. kansensis*, Eriocera, Hexatoma, and others
In or beneath damp cushions of moss	*Dicranomyia badia*, *D. stulta*, *Tipula oropezoides*, *T. collaris*, *T. nobilis*, *T. ignobilis*, and others
In or beneath dry cushions of moss	Liogma, Dolichopeza, Oropeza, and others
In dry soil	Dicranoptycha, Cladura, *Nephrotoma ferruginea*, *Tipula cunctans*, *T. angustipennis*, and others
In fungi	*Limnobia triocellata*, *L. cinctipes*, Ula, and others
In decaying vegetables, plant stems, manure, and like situations	Trichocera, *Limnobia indigena*, *Rhipidia domestica*, *R. maculata*, and others
In wood:	
a. In decaying wood, usually just beneath the bark	*Dicranomyia rara*, *D. macateei*, *Rhipidia fidelis*, *R. bryanti*, Elephantomyia, Teucholabis, Gnophomyia, *Limnophila unica*, Brachypremna, Ctenophora, Dictenidia, *Tipula trivittata*, *T. usitata*, and others
b. In nearly solid wood	Tanyptera
On leaves of terrestrial plants:	
a. On flowering plants	Cylindrotoma
b. On mosses	Liogma, Triogma (in some instances)
Mining in the leaves of plants	*Dicranomyia foliocuniculator*

Feeding.— The various larvae of crane-flies show a considerable diversity in their habits of feeding. The majority of species, as known, are herbivorous, but a large group are decidedly carnivorous in their habits.

The Tipulinae feed on the living vegetable tissue or plant remains occurring in their habitat, or, when pressed for food, they will eat earth-

worms (Patterson, 1908) and other soft-bodied animals. Dissections of *Tipula abdominalis* show the food of this species to consist principally of small filamentous algae, diatoms (Diatoma, Navicula, and others), and rootlets of small plants. The alimentary tract is often crammed with sand or soil particles. The species of Tipula and Nephrotoma that are injurious to plants, considered later in this paper under the heading *Economic Importance*, effect their damage by devouring the living tissues of the roots. The Cylindrotominae feed on the living tissues of the plants on which they dwell; in the case of Phalacrocera, Triogma, and Liogma these are mosses, in Cylindrotoma they are the parenchyma and epidermis of higher plants (spermatophytes). With this habit of feeding on plant tissues the extreme of sluggishness of motion is attained. The wood-boring species of Tipulinae (such as the species of Tanyptera and Ctenophora) feed on the ligneous tissue of the trees in which they occur. Other species of crane-flies injure young seedlings by destroying the bark and the bast tissues.

The hexatomine and pediciine forms represent the opposite extreme, being for the most part carnivorous or even cannibalistic in their habits. In order to capture their prey they are of necessity rapid of movement, and in this group the most graceful and active of all tipulid larvae are found. The motions of the species are, at times, exceedingly agile and snakelike. The food consists of a variety of animal forms. Dicranota has been recorded as feeding on worms of the genus Tubifex. Pedicia usually feeds on the larvae of small insects, especially Chironomidae, but the large species of this genus and of Eriocera are capable of capturing almost any insect of a size equal to their own. The larvae of *Eriocera spinosa* are able to inflict painful bites on tender parts of the skin of a man. Penthoptera, Eriocera, Hexatoma, and most of the limnophiline groups likewise feed largely on midge larvae. From one small larva of *Limnophila* (*Dicranophragma*) *fuscovaria* the writer has dissected out the remains of two large midge larvae, whose heads were nearly half the size of that of the captor. The chitinized mentum in these predacious forms is very weak or is lacking, allowing for a tremendous distension of the gular region. The mandibles are always developed into powerful curved hooks which serve well their purpose of grasping and holding the victims. The esophageal region is often retrorsely roughened to prevent the egress of anything that has once started down the throat. In addition to the

various chitinized jaws, legs, heads, and other insect remains, the distended proventricular regions usually show a considerable amount of sand particles and much plant tissue.

The pupa

When ready to pupate, the larva ceases feeding and becomes much contracted and sluggish. The pupa is formed within the last larval skin, which is then shed completely except in certain Cylindrotominae and a few scattered genera in other tribes, in which cases the larval skin adheres to the posterior end of the abdomen. The pupal existence is spent in or near the haunts of the larva.

In the strictly aquatic genus Antocha the pupa lives in water in a silken case, respiration being accomplished by means of the many-branched breathing horns. The species of Elliptera and certain Dicranomyia (*simulans*, for example) approach this aquatic condition. The other species of crane-flies with aquatic larvae known to the writer go to the soil in order to pupate, this category including Eriocera, Hexatoma, *Tipula caloptera*, *T. abdominalis*, and many others.

The pupae of some, at least, of the Cylindrotominae attach themselves to plant stems for the purpose of pupation. The leaf-mining *Dicranomyia foliocuniculator* pupates within the larval passages. The majority of the limnobiine forms spend the pupal existence in silken cases to which pebbles and particles of débris or plant tissues adhere.

The pupae of the Ptychopteridae have one of the two breathing horns enormously elongated, the tip of this being projected above the water level into the air for respiration. Certain tipuline crane-flies have a somewhat similar development of the breathing horns, discussed later.

The duration of the pupal existence is remarkably uniform thruout the group, averaging from six to eight days. The following table illustrates this for the more representative genera and species. Records which have not been determined sufficiently close, and which as stated are probably too long, are indicated by an asterisk.

Species	Duration of pupal existence (days)			Reference
	Maximum	Minimum	Average	
Ptychoptera rufocincta	.....	$4\frac{3}{4}$	.....	Alexander ms.
albimana	*12	10	11	Topsent, 1914–16
Bittacomorphella	*13	.....	.....	Alexander ms.
Dicranomyia badia	7	.....	7	Alexander ms.
stulta	*8	.....	.....	Alexander ms.
Rhipidia bryanti	7	.....	7	Shannon ms.
Limnobia cinctipes	.....	5	.....	Alexander ms.
triocellata	9	8	$8\frac{1}{2}$	Alexander ms.
Rhamphidia mainensis	6	.....	6	Alexander ms.
Dicranoptycha winnemana	*10	.....	.....	Alexander ms.
Ula elegans	*10	.....	.....	Alexander, 1915a
Epiphragma	.....	6	6	Alexander ms.
Pseudolimnophila	9	8	$8\frac{1}{2}$	Alexander ms.
Limnophila macrocera	9	8	$8\frac{1}{2}$	Alexander ms.
fuscovaria	*14	8	10	Alexander ms.
Pilaria	7	7	7	Alexander ms.
Ulomorpha	*9	.....	.....	Alexander ms.
Eriocera fultonensis	7	7	7	Alexander ms.
longicornis	7.3	.....	7.3	Alexander ms.
Hexatoma megacera	$6\frac{1}{2}$	.....	$6\frac{1}{2}$	Alexander ms.
Pedicia rivosa	*14	7	$10\frac{1}{2}$	Beling, 1879:46
Erioptera macrophthalma	8	7	$7\frac{1}{2}$	Alexander ms.
Molophilus hirtipennis	*10	.....	.....	Alexander ms.
Gnophomyia tristissima	5	4	$4\frac{1}{2}$	Hyslop ms.
Ormosia nigripila	*11	.....	.....	Alexander ms.
Teucholabis complexa	9	.....	.....	Johnson ms.
Elephantomyia	8	6	7	Shannon ms.
Cylindrotoma splendens	10	6	8	Cameron, 1918
Liogma glabrata	11	10	$10\frac{1}{2}$	Müggenberg, 1901
Phalacrocera replicata	8	7	$7\frac{1}{2}$	Bengtsson, 1897
Dolichopeza albipes	6	.....	6	Beling, 1886 (as *sylvicola*
Ctenophora angustipennis	.....	.....	10	Lovett, 1915
Dictenidia bimaculata	7	.....	7	Beling, 1873b
Tipula maxima	*14	*10	*12	Beling, 1886
oleracea	8	7	$7\frac{1}{2}$	Del Guercio, 1914:315
cayuga	7.6	.....	7.6	Alexander ms.
ignobilis	8	7	$7\frac{1}{2}$	Alexander ms.
dejecta	8	.....	8	Alexander ms.
collaris	8	7	$7\frac{1}{2}$	Alexander ms.
Nephrotoma lineata	7	.....	7	Beling, 1879 (as *histrio*
lunulicornis	7	.....	7	Beling, 1879
analis	*12	*8	*10	Beling, 1886

ENEMIES

Crane-flies have many enemies and but few means of combating them. Every stage of the crane-fly's existence is fraught with danger. The larvae of the majority of species are soft-bodied, herbivorous creatures, which form a choice morsel of food for carnivorous forms of many classes and orders. The period when the adult fly has just emerged from the pupal hull is undoubtedly the one in which the greatest danger is found, for then the insects are teneral and incapable of rapid motion. The adult flies are sometimes drowned in the sea or other large bodies of water and their dead fragments cast up in windrows on the shore. A very unusual instance of this kind is recorded for *Tipula oleracea* by Patterson (1908). At their best, the adult flies are poor, awkward fliers and are easily captured by a wide range of species, as indicated in the following pages.

Predatory natural enemies

Vertebrates

Mammalia.— Undoubtedly many of the smaller mammals prey on the larvae of various species of Tipula. In another paper (Alexander, 1919 d: 776–777) the writer has discussed the value of the larvae of an undetermined species of Tipula in the Pribilof Islands as an article of food for the arctic fox. These larvae occur in enormous numbers beneath the lichens of the tundra and the foxes can easily get them at a time when other food is scarce or unobtainable. Mice, shrews, and moles find an important element of their food from this source. White (1914) states that in North Wales the European mole, *Talpa europaea*, eats, on an average, twenty crane-fly larvae a day, these constituting one of the main foods of this mammal.

Aves.— Birds are well-known enemies of crane-flies, both in their immature stages and as adult flies. Hyslop (1910:129–130) lists ninety-one species of birds which are known to feed on crane-flies. Baer (1913) describes ravens and starlings as feeding on the larvae of a species of Tipula. While working with the United States Biological Survey, the writer was given the opportunity to examine files for records. His thanks for assistance in this work are due to Messrs. Kalmbach, McAtee, and Wetmore. The records of the Survey are based on an examination of the contents of the stomachs of many thousands of individuals, and furnish very valuable and fairly complete data on the North American

birds which prey on various stages of the Tipulidae. These records are here arranged according to the latest check list of the American Ornithologists' Union:[3]

Longipennes:
- Laridae:
  - *Larus delawarensis* Ord. Ring-billed gull
  - *L. franklinii* Rich. Franklin's gull
  - *Sterna hirundo* Linn. Common tern

Anseres:
- Anatidae:
  - *Mergus americanus* Cass. Merganser
  - *Anas platyrhynchos* Linn. Mallard
  - *A. rubripes* Brewst. Black duck
  - *Mareca americana* (Gmel.). Baldpate
  - *Nettion carolinense* (Gmel.). Green-winged teal
  - *Dafila acuta* (Linn.). Pintail
  - *Aix sponsa* (Linn.). Wood duck

Herodiones:
- Ardeidae:
  - *Egretta candidissima candidissima* (Gmel.). Snowy egret
  - *Butorides virescens virescens* (Linn.). Green heron

Limicolae:
- Phalaropodidae:
  - *Phalaropus fulicarius* (Linn.). Red phalarope
  - *Lobipes lobatus* (Linn.). Northern phalarope
  - *Steganopus tricolor* Vieill. Wilson's phalarope
- Recurvirostridae:
  - *Recurvirostra americana* Gmel. Avocet
  - *Himantopus mexicanus* (Müll.). Black-necked stilt
- Scolopacidae:
  - *Philohela minor* (Gmel.). American woodcock
  - *Gallinago delicata* (Ord). Wilson's snipe
  - *Arquatella maritima maritima* (Brünn.). Purple sandpiper
  - *Pisobia aurita* (Lath.). Sharp-tailed sandpiper
  - *P. maculata* (Vieill.). Pectoral sandpiper
  - *P. bairdii* (Coues). Baird's sandpiper
  - *Limosa fedoa* (Linn.). Marbled godwit
  - *Totanus flavipes* (Gmel.). Yellow-legs
  - *Heteractitis incanus* (Gmel.). Wandering tatler
  - *Bartramia longicauda* (Bechst.). Bartramian sandpiper
- Charadriidae:
  - *Charadrius dominicus dominicus* (Müll.). Golden plover
  - *Oxyechus vociferus* (Linn.). Killdeer
- Aphrizidae:
  - *Arenaria interpres interpres* (Linn.). Turnstone

Gallinae:
- Tetraonidae:
  - *Bonasa umbellus umbellus* (Linn.). Ruffed grouse

Raptores:
- Buteonidae:
  - *Ictinia mississippiensis* (Wils.). Mississippi kite

[3] Check list of North American birds, 3d ed., p. 1–430. American Ornithologists' Union. 1910.

Coccyges:
Cuculidae:
Coccyzus americanus americanus (Linn.). Yellow-billed cuckoo
C. erythrophthalmus (Wils.). Black-billed cuckoo
Cuculus canorus telephonus Heine. Kamchatka cuckoo
Pici:
Picidae:
Dryobates pubescens pubescens (Linn.). Downy woodpecker
D. nuttallii (Gamb.). Nuttall's woodpecker
Sphyrapicus varius varius (Linn.). Yellow-bellied sapsucker
S. thyroideus (Cass.). Williamson's sapsucker
Melanerpes erythrocephalus (Linn.). Red-headed woodpecker
Asyndesmus lewisi Riley. Lewis's woodpecker
Colaptes auratus auratus (Linn.). Flicker
Macrochires:
Caprimulgidae:
Antrostomus carolinensis (Gmel.). Chuck-will's-widow
Chordeiles virginianus virginianus (Gmel.). Nighthawk
C. acutipennis texensis Lawr. Texas nighthawk
Cypselidae:
Chaetura pelagica (Linn.). Chimney swift
C. vauxi (J. K. Towns.). Vaux's swift
Aëronautes melanoleucus (Baird). White-throated swift
Trochilidae:
Calypte anna (Less.). Anna's humming bird
Selasphorus rufus (Gmel.). Rufous humming bird
Passeres:
Tyrannidae:
Tyrannus tyrannus (Linn.). Kingbird
T. verticalis Say. Arkansas kingbird
T. vociferans Swains. Cassin's kingbird
Myiarchus crinitus (Linn.). Great-crested flycatcher
Sayornis phoebe (Lath.). Phoebe
S. sayus (Bonap.). Say's phoebe
S. nigricans (Swains.). Black phoebe
Myiochanes virens (Linn.). Wood pewee
M. richardsonii richardsonii (Swains.). Western wood pewee
Empidonax flaviventris (W. M. & S. F. Baird). Yellow-bellied flycatcher
E. difficilis difficilis Baird. Western flycatcher
E. virescens (Vieill.). Acadian flycatcher
E. traillii traillii (Aud.). Traill's flycatcher
E. minimus (W. M. & S. F. Baird). Least flycatcher
E. wrightii Baird. Wright's flycatcher
E. griseus Brewst. Gray flycatcher
Corvidae:
Pica pica hudsonia (Sab.). American magpie
Cyanocitta cristata cristata (Linn.). Blue jay
C. stelleri stelleri (Gmel.). Steller's jay
Corvus brachyrhynchos brachyrhynchos Brehm. American crow
C. ossifragus Wils. Fish crow
Sturnidae:
Sturnus vulgaris Linn. Starling
Icteridae:
Dolichonyx oryzivorus (Linn.). Bobolink
Molothrus ater ater (Bodd.). Cowbird

Passeres (*continued*):
Icteridae (*continued*):
Xanthocephalus xanthocephalus (Bonap.). Yellow-headed blackbird
Agelaius phoeniceus phoeniceus (Linn.). Red-winged blackbird
A. gubernator californicus Nels. Bicolored redwing
Sturnella magna magna (Linn.). Meadow lark
Icterus spurius (Linn.). Orchard oriole
I. galbula (Linn.). Baltimore oriole
I. bullockii (Swains.). Bullock's oriole
Euphagus cyanocephalus (Wagl.). Brewer's blackbird
Quiscalus quiscula quiscula (Linn.). Purple grackle
Fringillidae:
Leucosticte griseonucha (Brandt). Aleutian rosy finch
Plectrophenax nivalis nivalis (Linn.). Snow bunting
P. hyperboreus Ridgw. McKay's snow bunting
Calcarius lapponicus lapponicus (Linn.). Lapland longspur
Passerculus sandwichensis savanna (Wils.). Savanna sparrow
Zonotrichia leucophrys leucophrys (J. R. Forst.). White-crowned sparrow
Z. albicollis (Gmel.). White-throated sparrow
Junco hyemalis hyemalis (Linn.). Slate-colored junco
Passer domesticus (Linn.). English sparrow
Melospiza melodia melodia (Wils.). Song sparrow
M. lincolnii lincolnii (Aud.). Lincoln's sparrow
M. georgiana (Lath.). Swamp sparrow
Passerella iliaca iliaca (Merr.). Fox sparrow
Pipilo erythrophthalmus erythrophthalmus (Linn.). Towhee
Passerina amoena (Say). Lazuli bunting
Tangaridae:
Piranga ludoviciana (Wils.). Western tanager
P. erythromelas (Vieill.). Scarlet tanager
P. rubra rubra (Linn.). Summer tanager
Hirundinidae:
Progne subis subis (Linn.). Purple martin
Petrochelidon lunifrons lunifrons (Say). Cliff swallow
Hirundo erythrogastra Bodd. Barn swallow
Iridoprocne bicolor (Vieill.). Tree swallow
Tachycineta thalassina lepida Mearns. Northern violet-green swallow
Riparia riparia (Linn.). Bank swallow
Stelgidopteryx serripennis (Aud.). Rough-winged swallow
Bombycillidae:
Bombycilla cedrorum Vieill. Cedar waxwing
Vireonidae:
Vireosylva olivacea (Linn.). Red-eyed vireo
V. philadelphica (Cass.). Philadelphia vireo
V. gilva gilva (Vieill.). Warbling vireo
Lanivireo solitarius solitarius (Wils.). Blue-headed vireo
Vireo griseus griseus (Bodd.). White-eyed vireo
V. bellii bellii Aud. Bell's vireo
V. bellii pusillus Coues. Least vireo
Mniotiltidae:
Mniotilta varia (Linn.). Black-and-white warbler
Helmitheros vermivorus (Gmel.). Worm-eating warbler
Dendroica aestiva aestiva (Gmel.). Yellow warbler
D. coronata (Linn.). Myrtle warbler
D. auduboni auduboni (Towns.). Audubon's warbler

Passeres (*continued*):
Mniotiltidae (*continued*):
D. dominica dominica (Linn.). Yellow-throated warbler
Oporornis tolmiei (J. K. Towns.). Macgillivray's warbler
Geothlypis trichas trichas (Linn.). Maryland yellowthroat
Icteria virens virens (Linn.). Yellow-breasted chat
Wilsonia pusilla pusilla (Wils.). Wilson's warbler
Setophaga ruticilla (Linn.). American redstart
Motacillidae:
Anthus rubescens (Tunst.). Pipit
Mimidae:
Mimus polyglottos polyglottos (Linn.). Mocking bird
Dumetella carolinensis (Linn.). Catbird
Toxostoma rufum (Linn.). Brown thrasher
T. redivivum (Gamb.). Californian thrasher
Troglodytidae:
Heleodytes brunneicapillus couesi (Sharpe). Cactus wren
Salpinctes obsoletus obsoletus (Say). Rock wren
Catherpes mexicanus punctulatus Ridgw. Dotted canon wren
Thryothorus ludovicianus ludovicianus (Lath.). Carolina wren
Thryomanes bewickii bewickii (Aud.). Bewick's wren
Nannus hiemalis hiemalis (Vieill.). Winter wren
Telmatodytes palustris palustris (Wils.). Long-billed marsh wren
Paridae:
Baeolophus inornatus inornatus (Gamb.). Plain titmouse
Penthestes atricapillus atricapillus (Linn.). Chickadee
P. carolinensis carolinensis (Aud.). Carolina chickadee
P. gambeli gambeli (Ridgw.). Mountain chickadee
P. hudsonicus hudsonicus (Forst.). Hudsonian chickadee
Psaltriparus minimus minimus (J. K. Towns.). Bush-tit
Chamaeidae:
Chamaea fasciata fasciata (Gamb.). Wren-tit
Sylviidae:
Regulus calendula calendula (Linn.). Ruby-crowned kinglet
Turdidae:
Myadestes townsendi (Aud.). Townsend's solitaire
Hylocichla mustelina (Gmel.). Wood thrush
H. fuscescens fuscescens (Steph.). Veery
H. aliciae aliciae (Baird). Gray-cheeked thrush
H. ustulata ustulata (Nutt.). Russet-backed thrush
H. ustulata swainsoni (Tschudi). Olive-backed thrush
H. guttata pallasii (Cab.). Hermit thrush
Planesticus migratorius migratorius (Linn.). American robin

The principal families that feed on the adult flies are the Caprimulgidae, the Cypselidae, the Tyrannidae, the Icteridae, the Hirundinidae, the Mniotiltidae, the Troglodytidae, the Paridae, and the Turdidae.

Many species of birds feed on the larvae of crane-flies, the more notable of these being the water-fowl, Anatidae, the shore birds, Scolopacidae, and the thrushes, Turdidae. Sim (1907) has recorded the chestnut-sided warbler, *Dendroica pensylvanica* (Linn.) as feeding on *Tipula* sp.

In Europe the raven and the starling are important, as already stated. Patterson (1908) records the starling as eating great numbers of *Tipula oleracea* and as boring into the soil in search of the larvae of this species.

It will be noted that in the foregoing list no species of doves or pigeons are recorded in this country as feeding on Tipulidae. The following note on an Australian pigeon shows the importance of the larvae as a food for these birds: [4]

Mr. North exhibited the head, crop, and gizzard of a wonga-wonga pigeon (*Leucosarcia picata* Lath.) shot by Mr. H. J. McCooey in a myrtle scrub at Upper Burragorang on the 21st inst. The crop is absolutely crammed with dipterous larvae (*Habromastix cinerascens* Sk.) and undigested portions of them mixed with seeds, berries, and earth appear also in the gizzard. As the larvae are known to be destructive to grass, the wonga-wonga would appear to be deserving of consideration.

Amphibia.— Crane-flies, both larvae and adults, form a considerable element of the food of many Amphibia. The studies by Needham (1905:13) show this to be true in the case of the bullfrog, *Rana catesbeiana* Shaw. Munz (1920) studied the food habits of eight species of Anura and found that five fed on crane-fly larvae or adults. These species were *Rana clamitans* Latr., *R. sylvatica* Lec., *R. palustris* Lec., *R. pipiens* Schreb., and *Hyla crucifer* Wied. The following additional records are given:

Desmognathus fusca Raf. Dusky salamander. Wings of a Limnophila found in a specimen from Ithaca, New York. (A. A. Noyes.)

Rana clamitans Latr. Green frog. Two larvae of a Tipula, near *dejecta* Walker, found in stomach. (S. W. Frost.)

Bufo lentiginosus woodhousei Girard. Centerville, Utah, April 27, 1912. Twenty-six per cent of the food of this species consisted of a large tipulid. (E. R. Kalmbach.)

Bufo sp. Washington, D. C., May 17, 1890. One per cent tipulid larvae. (W. L. McAtee.)

Pisces.— The larvae of crane-flies furnish favorite morsels for many carnivorous species of fish, and as a consequence they are in considerable demand with fishermen as bait for bass and other game fish. These include the larvae of the larger species of Eriocera and many large semi-aquatic species of Tipula, especially *Tipula caloptera* and *T. abdominalis*. Fragments of the adult flies are often found in the stomach contents of fish, notably species of trout, most of these pieces being of individuals that

[4] Linn. Soc. New South Wales. Proc., ser. 2:9:585. 1894.

had fallen into the water or were captured while newly transformed. Forbes (1888) records Coregonus and Hyodon as feeding on the eggs, and Notropis as feeding on the larvae, of crane-flies. Levander (1909:1) records *Perca fluviatilis* Linn. as feeding on larvae of Tipulidae.

Invertebrates

Arachnida.— Some spiders are notable enemies of crane-flies, which fall easy victims while in a helpless, teneral condition. These spiders represent many families, such as the Thomisidae, the Lycosidae, the Attidae, the Epeiridae, and others (Alexander and Lloyd, 1914:15; also, Alexander, 1915c:144). An account of their preying on the larger crane-flies of the genus Tipula is given under the discussion of *T. taughannock* (page 1013). In a recent paper Bilsing (1920) has recorded four species of crane-flies eaten by spiders. These spiders represented thirteen species arranged in four families — the Lycosidae, the Attidae, the Epeiridae, and the Agelenidae. J. R. Malloch found a female *Tipula angustipennis* which was being eaten by a crab spider, determined by Mr. Banks as *Xysticus ferox* Htz. The spider did not release its hold until after it was placed in a jar of cyanide.

Hexapoda.— Odonata: The following records of dragon-flies found feeding on adult crane-flies are available: *Gomphus vastus* Walsh and *G. ventricosus* Walsh, found feeding on *Tipula bicornis* at South Bend, Indiana, May 30, 1914 (E. B. Williamson); *Helocordulia uhleri* (Selys), found feeding on *Eriocera longicornis* (Alexander, 1915c:152); *Agrion vuella* Linn., found feeding on *Erioptera flavescens* (Campion, 1914:498). C. H. Kennedy has sent the writer a male and a female specimen of a small crane-fly, *Teucholabis pabulatoria* Alex., which he found in the mouth of a damsel fly, *Hetaerina tricolor* Burm., collected in Guatemala by Professor Hine. Needham and Hart (1901–03 [1901]:47) record the nymphs of *Anax junius* (Dru.) feeding on the larvae of Tipulidae.

Diptera: The adult flies of at least three families of the order Diptera —the Asilidae, the Empididae, and the Scatophagidae—and the larvae of a fourth, Anthomyiidae, are notable enemies of crane-flies. The records of Kirby (1892), Poulton (1906–07), Bromley (1914), Alexander (1915c), and McAtee and Banks (1920) on the first three of these families may be summarized as follows:

Asilidae (robber flies)	Prey
Lasiopogon cinctus (Fabr.)	*Nephrotoma lineata* (Scop.) (Poulton, 1906–07, as *histrio* [Fabr.])
Neoitamus cyanurus (Lw.) (in copulation with female, the latter with the crane-fly)	*Tipula scripta* Meig. (Poulton, 1906–07)
Proctacanthus philadelphicus Macq.	*Nephrotoma* sp. (2 records, Bromley, 1914)
Asilus sp.	*Nephrotoma ferruginea* (Fabr.) (3 records, Alexander, 1915 c)
Asilus flavofemoratus Hine	*Tipula* sp. (McAtee and Banks, 1920:30)
Asilus notatus Wied.	*Nephrotoma ferruginea* (Fabr.) (McAtee and Banks, 1920:31)
Asilus paropus Walk.	*Epiphragma solatrix* (O. S.) (McAtee and Banks, 1920:31)
Asilinae	*Tipula lateralis* Meig. (Poulton, 1906–07)

The Empididae, or dance flies, are small, predacious flies which are closely related to the robber flies and largely replace them in moist shaded situations. They unquestionably play a most important part in the economy of the Tipulidae, since both groups are practically confined to the same general situations and, in the temperate regions at least, representatives of the two groups are invariably found together. Macquart (Kirby, 1892:229), discussing *Empis livida* Linn., writes as follows: "Among the thousands of pairs which I have noticed resting on bushes or hedges, nearly all the females were engaged in sucking some insect, sometimes small Phryganidae or Ephemeridae, but more often Tipulidae. They busy themselves with feeding and perpetuating their species at the same time." Howlett (1907) records *Empis borealis* Linn. as feeding on Tipulidae. The following records are from Poulton (1906–07:380–382): *Empis tesselata* Fabr. preys on *Tipula lunata* Linn., *T. paludosa* Meig., and other species; *Empis livida* Linn. preys on *Dicranomyia* sp. (It is probable that the long-legged flies, Dolichopodidae, likewise play an important rôle in the lives of the Tipulidae, but no records are available to the writer to confirm this belief.)

The Scatophagidae (Cordyluridae), or dung flies, unquestionably play an important part in the lives of the smaller crane-flies (Limnobiinae). The following records indicate this relationship, the last being supplied by Malloch:

Enemy	Prey
Scatophaga suilla (Fabr.)	*Dicranomyia lutea* (Meig.) (Poulton, 1906–07)
Scatophaga sp. (*stercoraria?*)	*Erioptera* sp. (Poulton, 1906–07)
Scatophaga sp.	*Hexatoma megacera* (O. S.) (Alexander, 1915 c)
Scatophaga stercoraria (L.) and *squalida* Meig.	*Trichocera* (Malloch, 1911)

Comparatively recently the larvae of Anthomyiidae have been found to play a highly important rôle in the economy of other insects living in the same haunts. The very important paper by Keilin (1917) may be consulted in connection with this point. This student found the following Anthomyiidae associated with Tipulidae: *Graphomyia maculata* Scop., feeding on larvae of *Ptychoptera contaminata* (L.) (Keilin, 1917:354–360); *Allognota agromyzina* Fall., associated with and possibly feeding on the larvae of *Ula macroptera* Macq. (page 360–362 of reference cited); *Phaonia cincta* Zett., feeding on larvae and pupae of *Mycetobia pallipes* (page 362–375 of reference); *Phaonia goberti* Mik, associated with and possibly feeding on the larvae of *Gnophomyia tripudians* Bergr. (page

375–377 of reference); *Mydaea pertusa* Meig., possibly feeding on larvae of Tipulidae (page 393–396 of reference).

A species of Phaonia with presumably parasitic habits is discussed on page 732 of this memoir.

Coleoptera: The adults and the larvae of the following species of ground beetles (Carabidae) have been recorded as important enemies of crane-flies (Hyslop, 1910): *Poecilus lucublandus* Say; *Micromaseus femoralis* (Kirby); *Platynus* sp.; *Harpalus pennsylvanicus* Dej.; *H. caliginosus* Fabr. Most of these were recorded by Webster (1893 a:241) as feeding on the injurious crane-fly *Tipula bicornis*.

The larvae of Elateridae (wireworms) are enemies of crane-flies. The writer has seen several feeding on large larvae of *Tipula trivittata*.

Hymenoptera: Ants (Formicidae) undoubtedly capture and devour many crane-flies, these generally being pupae or teneral adults. Hyslop (1910) cites the record of an *Aphaenogaster fulva* Roger which was observed dragging a living adult tipulid over the ground. Chapman (1918:191) records feeding species of Myrmica on adult Tipulidae which were readily eaten by the ants in preference to most other insect food. On August 2, 1917, at Larned, Pawnee County, Kansas, along the bank of the Arkansas River, the writer noted a small ant which was dragging a still living pupa of *Gonomyia kansensis* from its burrow in the sand at the bank of the river. The ant had the pupa about the head and carried it off despite its struggles. Both the Gonomyia and the formicid were common and the tragedy as described was not accidental.

The Pemphredonidae (Mimesinae) and the Crabronidae, fossorial wasps in the Hawaiian Islands, bear an important relationship to the smaller Tipulidae dwelling in the same haunts. Writing of the Mimesinae, a subfamily of the Pemphredonidae, Perkins (1913:lxxxv) says:

> All the Hawaiian species of both genera are true forest insects and most of them may be seen in large numbers, where they occur, flying around ferns and bushes in sunny places. The males are often much more numerous apparently than the females, but this is due to the more retiring habits of the latter, which, when they have begun to provision their nests, frequent dark, shady and damp places in search of their prey. This consists of the endemic Limnobiidae or daddy longlegs, which live in such places. . . . Although I have often watched females of these wasps returning with prey to their burrows, it was always Tipulidae that they carried to the nest. Their burrows are usually made in the ground and are often drilled down from beneath a stone, this no doubt serving to keep the burrow sufficiently dry.

Referring to Limnobiinae, Perkins says (page clxxxii of the same reference):

The species of Dicranomyia are endemic, and to the five described, others and perhaps many more will, no doubt, be added. They are common insects, sometimes attracted by light and sometimes observed at rest in the daytime, or on the wing in the dark cavity of some hollow tree. In the latter case a number are usually seen flying together, rising and falling in their flight in the narrow space of a few feet. We have bred one or more species from decayed wood, overgrown with damp moss. These fragile flies are the favourite prey of the endemic predaceous wasps of the family Mimesidae, and some of the Crabronidae likewise gather them. Consequently one may find the females of these wasps investigating damp, dark places, where the Dicranomyia are likely to be found, but which ordinarily would have but little attraction for such sun-loving insects.

Writing of the Crabronidae, Perkins says (page lxxxvi of the reference cited):

Xenocrabro hawaiiensis on one occasion was caught carrying off Lispe [Anthomyiidae] and on another occasion a species of the limnobiid Dicranomyia.

De Meijere (1920:59) records *Crabro* (*Rhopalum*) *tibiale* as provisioning its nest principally with *Molophilus armatus* Meij.

Parasitic natural enemies

External parasites

Besides the predatory forms just considered, the various stages of the existence of many crane-flies are threatened with parasites which are equally effective altho more insidious in their method of attack. There are unquestionably many parasites of crane-flies concerning which nothing at all is known at this time. It is inconceivable that such species as *Holorusia grandis*, *Tipula abdominalis*, and other large and common forms do not serve as hosts for parasites as yet unknown. It is this field of investigation that now promises some of the most valuable results.

Hexapoda.— The only parasitic insects of which the writer knows are the dipterous Tachinidae. Glover (1874) states that in Europe certain Tipulae are destroyed by a proctotrupid parasite of the genus Diapria Latreille. Kieffer, in his monograph of the Diapriidae (1911), does not mention this and the writer has not seen it referred to elsewhere. It is probable that the reference pertains to some of the smaller Tipula-like forms of another family. However, it is very strange that one or more of the many families of parasitic Hymenoptera do not infest some stage of the Tipulidae, and it may be confidently predicted that such parasites will one day be discovered.

Tachinidae: Most of the species of the interesting genus Siphona (Bucentes) are parasitic on the caterpillars of various Lepidoptera. Two have been recorded as parasites of the larvae of species of Tipula. The better-known of these is *Siphona cristata* (Fabr.), a constant parasite of the larvae of *Tipula maxima* (Beling 1886, Czizek 1913, Riedel 1913, Thompson 1915). The method of attack by the parasite has been described by Roubaud (1906). The large, massive larvae of this species of crane-fly are amphibious or semi-aquatic, living near the margins of streams and other bodies of water. They live in the mud or in the water beneath the surface, at times coming up to breathe the air thru the two large spiracles at the posterior end of the body. It is at this time, when the spiracular disk is projected thru the surface film and the spiracles are open, that the tachinid is supposed to dart down and deposit its eggs in the open stigmata. The young parasite is somewhat elongated, yellowish orange in color, and about a millimeter in length, and is completely inclosed in a firm, membranous cyst. It is connected with one of the two principal tracheal trunks of the host by a sort of chitinized calyx which opens into the trachea. At the time of their pupation the parasites detach their organs of fixation, and with their heads perforate the skin of the host and enter the humic earth. In nature this departure coincides almost exactly with the time of leaving the water by the host for the purpose of pupation in the earth. The pupal duration of the parasite is about three weeks. Rennie (1912) gives *Siphona geniculata* (De Geer) as a parasite of an undetermined species of Tipula.

Species of the genus Admontia are important parasites of the larvae of crane-flies. In Europe, *Admontia amica* (Meig.) is parasitic on species of Tipula, while in America *A. pergandei* Coq. is an important parasite of the smoky crane-fly, *Tipula cunctans* (Hyslop, 1910:128). In the collection of the Illinois Natural History Survey are several specimens of *A. pergandei* bred from larvae of the smoky crane-fly (larvae taken at Urbana, Illinois, parasites emerged October 9 to 25, 1900). Averin (1913) and Lutchnik (1916), in Russia, record the larvae of a Tipula, in one case at least — that of the economic species *T. oleracea* — as being very heavily infested by an undetermined tachinid which may have been the Admontia species mentioned above.

A third genus of Tachinidae, Sturmia, has recently been reported to the writer by J. D. Tothill as being parasitic on the larva of a large crane-

fly, undoubtedly a tipuline form. The larva was found at Chelsea, near Ottawa, on May 27, 1906, by Dr. James Fletcher, the parasite issuing on June 27. The tachinid is to be described as *Sturmia tipulensis* Tothill.

The genus Trichoparia is parasitic on Ctenophora and its allies.

Altho the Tachinidae are the only dipterous parasites that are definitely known from the Tipulidae, the writer has a record of a species of Phaonia, of the family Anthomyiidae, which possibly is a parasite. Among some Diptera sent to Malloch for naming was one specimen of a Phaonia bearing the label "Bred from tipulid pupa, acc. no. 14022." The writer is indebted to R. H. VanZwaluwenburg for the following facts concerning this specimen: The material was taken by Harry L. Parker on June 6, 1916, on South Mountain, near Hagerstown, Maryland. Under litter and growth of Virginia creeper on rock a tipulid pupa was found. The pupa had been eaten out inside and there was a hole in the side of its body. About a half inch away from this pupa was found a newly formed pupa of an anthomyiid fly. The adult emerged on June 23, 1916, and was pinned. It is possible, of course, that the Phaonia was merely feeding on the tipulid, as recorded for this genus elsewhere in this paper (page 728), and that the species is a predatory enemy rather than a parasite.

Arachnida.— Young mites of species of Trombidium, Rhyncholophus, and other genera of Arachnida, are frequently found attached to the body and the wings of adult crane-flies. This attachment is by anal filaments, and it is doubtful whether any real injury results to the host therefrom. These cases are probably instances of phoresy to provide a means of dispersal of the mite. At various times the writer has found in northeastern America a large number of adult crane-flies so infested, and practically every genus and many species are included among the number.

Fungi.— Among the enemies of crane-flies, both to the immature and to the adult stages, probably none are more lethal in their action than certain parasitic fungi. The largest groups of insect-fungous parasites are the Entomophthoraceae (Phycomycetes) and the Laboulbeniaceae (Ascomycetes). Dr. Roland Thaxter informs the writer that, altho the latter group infest other Diptera, he has never seen specimens on Tipulidae, and none have been recorded in the literature. The writer is greatly indebted to Dr. Thaxter and to A. T. Speare, Government Mycoentomologist, for data on this subject. Dr. Thaxter sent to the writer for determination a considerable number of specimens of crane-flies with their para-

sites, these including the types of many of his Entomophthoraceae and some new species not yet described. From these data and the literature the following notes may be given:

Class, Phycomycetes
Family, Entomophthoraceae

1. *Entomophthora* (*Empusa*) *pachyrrhinae* Arthur. On the larvae of *Nephrotoma ferruginea*; a manuscript name.
2. E. (E.) *sepulchralis* (Thaxt.). On an adult Tipula of the *subunicolores* group.
3. *E.* (*E.*) *caroliniana* (Thaxt.) [= *E. arrenoctona* Giard]. On an adult male of *Tipula entomophthorae.*
4. *E.* (*E.*) *arrenoctona* Giard. On male adults of *Tipula paludosa* (Giard 1888, Villeneuve 1910, Picard 1913).
5. *E.* (*E.*) *tipulae* Fres. On *Tipula maxima* (Lohde, 1872).
6. *E.* (*E.*) *conglomerata* (Sorokin). A species which is probably this one is recorded by Thaxter on larvae and adults of Tipulidae.
7. *E.* (*E.*) *sphaerosperma* Fres. Recorded by Thaxter from adult Tipulidae.
8. *E.* (*E.*) *grylli* Fres. Recorded on at least two occasions from the adult flies of *Tipula ultima* Alex. [= *T. flavicans* Fabr.].
9. *E.* (*E.*) *punctata* Thaxt., ms. On adult females of *Pseudolimnophila noveboracensis.*
10. *E.* (*E.*) *dipterigena* (Thaxt.). On the adult flies of several genera of Limnobiinae, as follows: *Molophilus hirtipennis, Limnophila aprilina, Pseudolimnophila nigripleura, Ulomorpha pilosella, Penthoptera albitarsis.*
11. *Isaria* sp. On adults of *Dicranomyia pubipennis.* Additional undetermined species of this same genus on various tropical Tipulidae.

Class, Hyphomycetes.
Family, Mucediniaceae.

12. *Sporotrichum densum* Link. On *Tipula cunctans* Say [= *T. infuscata* Lw.] (Hyslop, 1910:130).

Internal parasites

Crane-fly larvae and adults are infested by numerous protozoan and bacterial parasites, the more conspicuous and constant being the Sporozoa (Gregarinidae) and the Bacteria. General references to this subject may be found in Léger (1892), Labbé (1899), and Minchin (1903). More especial references are made to the parasites of Ptychoptera by Léger and Duboscq (1909), to those of Dicranota by Miall (1893: 237), to those of Ctenophora by Anthon (1908:542), and to those of Tipula by Mackinnon (1913). In the case of Ctenophora the parasites were frequent between the cells of the alimentary canal, especially in the proventricular caeca. The writer has found a large gregarine very abundant in the alimentary canal of the larva of *Pedicia albivitta,* many of the individuals being very heavily infested. Gamkrelidze (1913 b) records gregarine and nematode parasites in Gnophomyia larvae.

The more important recorded protozoan parasites are as follows:

Class, Sporozoa.
Subclass, Telosporidia.
Order, Coccidiomorpha.
Family, Adeleidae.

1. *Adelea tipulae* Léger. In the intestine of species of Tipula.

Order, Gregarinida.
Family, Gregarinidae.

2. *Hirmocystis polymorpha* (Léger, 1892:113). In the intestine of the larva of *Limnobia* sp.
3. *H. ventricosa* (Léger, 1892:111). In the alimentary canal of *Tipula oleracea*, *Nephrotoma pratensis*, and other species.
4. *Gregarina longa* (Léger, 1892:117). In the alimentary canal of a species of Tipula.

Family, Actinocephalidae.

5. *Actinocephalus tipulae* Léger (1892:141). In the alimentary canal of Tipula larvae. Probably the same species has been recorded from the larvae of a species of Ctenophora.
6. *Pileocephalus striatus* Léger & Duboscq (1909:887–893). In the mid-intestinal epithelium of the larva of *Ptychoptera contaminata*. The Pileocephalus live in the epithelium of the mid-intestine, attaching themselves to the epithelial cells and hypertrophying the adjoining tissues. They obtain their nutriment from the food that penetrates into the cells.

Family, Stylorhynchidae.

7. Near Stylorhynchus (Miall, 1893:237). In the stomach of larvae of *Dicranota bimaculata*.

Subclass, Neosporidia.
Order, Cnidosporidia.
Suborder, Microsporidia.
Family, Nosematidae.

8. *Nosema strictum* Monz. (Moniez, 1887). In muscles, conjunctive tissue, and other parts of *Nephrotoma pratensis*.
9. *Gurleya francottei* Léger & Duboscq (1909:894). In the epithelium of the mid-intestine of the larva of *Ptychoptera contaminata*.

Class, Flagellata.
Family, Trypanosomidae (Herpetomonadidae).

10. *Crithidia campanulata* Léger. At the juncture of the mid- and hind-intestines in the larva of *Ptychoptera contaminata* (Léger & Duboscq, 1909:898–900).

The writer is indebted to Dr. R. Kudo for assistance in determining the terminology used above.

Bacteria are frequently found in crane-fly larvae. Léger and Duboscq (1909:900–901) record undetermined spirochaetes in the epithelial cells of the posterior part of the mid-intestine of *Ptychoptera contaminata*. Dr. Hugh Glasgow, of the Geneva Experiment Station, informs the writer that in Illinois a large tipulid larva, probably that of *Tipula abdominalis*, living in the leaf-drift of prairie streams, is heavily infested with bacteria. Most of the specimens observed had an abundance of small coccus and spirochaete forms, with occasional specimens of a gigantic bacillus measuring from forty to eighty microns in length and disporous. These large bacilli infest the hind-gut of the larva.

HISTORICAL SUMMARY OF THE IMMATURE STAGES

The discovery and description of the immature stages of crane-flies has by no means kept pace with the taxonomic work that has been done on the adult flies. There are a very large number of common species in every country concerning whose early stages nothing at all is known, and the knowledge that exists concerning a comparatively small number results from the labors of a few students. Among these may be mentioned Beling, Mik, Brauer, Hart, Needham, and Malloch. Some other workers have given excellent descriptions of single species, while still others have contributed important treatises on the anatomy, morphology, histology, and related subjects of the different species. The descriptions of the earlier workers are, for the most part, of historical interest only, but in a few cases they are exceptional and are still the main source of information concerning certain species. Many of the foremost workers on the taxonomy of the adult flies have summarized the earlier writings on the immature stages but have themselves contributed little to the subject, among these being Schiner, Loew, Osten Sacken, Skuse, and Brunetti. The following chronological summary gives an indication of the more important work that has been done on this phase of the subject:

'22	Frisch	*Tipula oleracea*
'40	De Réaumur	Ptychoptera, Tipula
'76	De Geer	Phalacrocera, Ctenophora, Tipula
'03	Schellenberg	Cylindrotoma
'29	Stannius	*Limnobia xanthoptera* [=*bifasciata*]
'32 (Posthumous)	Lyonet	Ptychoptera
'33	Bouché	*Dictenidia* sp., *Tipula* sp.
'34	Von Röser	*Hexatoma nigra*
'38	Boie	Cylindrotoma
'40	Dufour	Trichocera
'42	Zeller	Cylindrotoma
'46	Bremi-Wolf	Trichocera, *Limnobia xanthoptera* [=*bifasciata*], Nephrotoma
'49	Perris	Trichocera, *Limnophila dispar*, Ula, Tanyptera
'54	Brauer, Egger, and Frauenfeld	Chionea
'67	Nowicki	*Dactylolabis wodzickii*
'72	Weyenbergh	Ctenophora, Dictenidia: anatomy and histology
'73–86	Beling	The immature stages of 69 species of European Tipulidae, including 30 species of Tipula
'75–76	Hammond	*Tipula oleracea*: anatomy
'76	Grobben	Ptychoptera: anatomy
'76–1902	De Rossi	*Liogma glabrata*, *Tanyptera atrata*
'80	Hermann	*Tanyptera atrata*
'82–1900	Mik	Discobola, Elliptera, Dactylolabis, *Tipula rufina*, etc.

1883	Brauer	Important work on the classification of th immature stages
1884	Gercke	*Rhamphidia longirostris*, *Tanyptera atrata*
1890	Van Gehuchten	Ptychoptera: histology of alimentary canal
1893–97	Miall	Dicranota, Phalacrocera
1895 [1898]	Hart	Pioneer American worker; Bittacomorpha, etc.
1897	Bengtsson	Phalacrocera: anatomy
1900–09	Johnson	Teucholabis, Aeshnasoma, etc.
1901	Kellogg	*Holorusia grandis* (as *rubiginosa*): anatomy
1901	Müggenberg	*Liogma glabrata*
1901–08	Needham	*Dicranomyia simulans*, *Pedicia albivitta*, Rhaphi dolabis, *Tipula ultima* (as *flavicans*)
1907–08	Steinmann	*Triogma trisulcata*
1908	Holmgren	Phalacrocera: mouth parts
1908	Anthon	*Ctenophora angustipennis*: anatomy
1908–09	Pastejrík	*Limnobia xanthoptera*, Ctenophora
1908–09	Müller	*Triogma trisulcata*
1909	Brocher	*Tipula lunata*
1909	Greene	*Tipula trivittata*
1909	Thienemann	*Dicranomyia trinotata*
1910	Brown	*Tipula maxima*: anatomy
1910	Hyslop	*Tipula cunctans* (as *infuscata*)
1911	Vimmer	Ctenophora, *Tipula oleracea*: mouth parts
1911–16	De Meijere	*Trentepohlia pennipes*, *Tipulodina pedata*, an several European species
1912	Keilin	Trichocera: morphology
1913	Caudell	*Tipula ultima* (as *flavicans*)
1913	Gerbig	Anatomy of the respiratory system of many European species of Tipulidae
1913	Picado	*Trentepohlia bromeliadicola*
1914	Del Guercio	*Tipula oleracea*
1914–16	Topsent	*Ptychoptera albimana*
1914–19	Alexander	Dicranoptycha, Ula, Eriocera, Hexatoma, Penth optera, Liogma, Prionocera, *Tipula arctica*
1915	Swezey	*Dicranomyia foliocuniculator*
1915	Lovett	*Ctenophora angustipennis*
1915	Wesenberg-Lund	Dicranota, Phalacrocera, Triogma
1915–17	Malloch	*Limnobia immatura*, Gnophomyia, and, in hi uncertain material, Antocha, Elephantomyia
1916–17	Rennie	*Tipula paludosa*
1918	Cameron	*Cylindrotoma splendens*
1920	Hudson	*Gnophomyia rufa*, *Limnophila sinistra*
1920	Lenz	Thaumastoptera, Cylindrotominae

ECONOMIC IMPORTANCE

The larvae of some species of crane-flies, almost all belonging to the genera Tipula and Nephrotoma, often do considerable damage to various crop species, the injury being largely caused by the larvae devouring the roots and thus killing the plants. Certain of these crane-fly species, as *Tipula oleracea*, *T. paludosa*, and *Nephrotoma maculata* in Europe, and *Tipula bicornis* and *Nephrotoma ferruginea* in America, have long been known, but several others have come into prominence only within the

past ten years, notably *Tipula parva* Lw. (supposition) in Japan, and *T. cunctans* and *T. simplex* in North America. The more important outbreaks of this nature which have been recorded are as follows.

Species affecting herbaceous plants

Nephrotoma ferruginea has been reported by Webster (1891, and 1893 a: 243–245) as injuring young wheat in Indiana, the injury in some cases being estimated at fifty per cent.

Tipula oleracea is the best-known European species in this group, infesting a wide range of plants. The more important outbreaks of this species as recorded are as follows: Ewert (1899) reports from Germany an unusually severe attack, in which the larvae of this species and of *Tipula nigra* did a considerable amount of damage to the roots of grasses. They were so abundant that from ten to twenty could be found in the area of one square foot. Grasses in the infested area were completely destroyed. Ormerod (1885, 1886, 1900) records serious injury by *T. oleracea* to pastures and meadows in England, and recommends applications of guano either alone or mixed with salt, kainit, or superphosphate. This species has been recorded also as being a serious pest in Ireland (Anonymous reference, 1904 b) in grainfields and meadows, and careful plowing and the use of fertilizers for its control are advised. Schoyen (1903), in Norway, reports serious injury to meadows and pastures, as well as to cereals and young cabbage plants. Del Guercio (1914) records serious injury in the Italian rice fields.

A few additional outbreaks of *Tipula oleracea* may be mentioned. Barthou (1913) records injury to canes (raspberry, strawberry, and others) in France. Désoil (1914) reports injury to meadows in France, and Ritzema Bos (1915) to meadows in Holland.

Tipula paludosa is reported by Lind, Rostrup, and Kolpin Ravn (1914 and 1915) as causing serious injury to oats and barley in Denmark, and Rennie (1916 and 1917) reports the same species as injuring corn and pastures in England.

Tipula flavolineata is reported by Sopotzko (1916) as injuring clover in Russia. The specific identity, however, is probably erroneous, as this species lives almost entirely in decaying wood (Beling, 1873 b: 581–582).

Onuki (1905) records *Tipula parva* Lw. (supposition) as one of the serious rice pests in Japan. In some localities from sixty to ninety per

cent of the seedlings have been destroyed by this species. The larvae apparently cannot exist in water for any long period of time, and so may be killed by flooding the fields for from six to thirty-six hours. Del Guercio (1914) offers the same recommendation for the control of *T. oleracea* in the Italian rice fields.

Tipula bicornis has been found in grass and clover lands in Illinois by Forbes (1890), and on clover in Indiana by Webster (1892a).

Tipula cunctans, as recorded by Hyslop (1910:126, as *T. infuscata*), works largely on Japan clover and other leguminous plants. The larvae are often exceedingly numerous, as many as two hundred having been found in an area covering but little more than one square foot of soil. They destroy the plants by devouring the roots and sucking the juices. It is recommended that the infested fields be plowed under before the adult flies emerge (in the autumn), and the following season be planted to corn or potatoes or else left fallow.

Tipula simplex has been found on pasture land and alfalfa in California by Doane (1908) and by Carnes and Newcomer (1912). Doane (cited by Hyslop, 1910:120–121) also reports an outbreak of this species on wheat and grass lands and in clover fields in central California in 1907, and states that thousands of acres of these crops were stripped of their verdure.

The following summary gives the various species of plants that are damaged or destroyed by crane-flies in general. Very many of the injuries reported for *Tipula oleracea*, however, are omitted.

Family	Crop	Species	Authority
Gramineae	Wheat	*Nephrotoma ferruginea*	Webster (Indiana), 1891, 1893a
	Wheat	*Tipula simplex*	Hyslop (California), 1910
	Wheat	Tipulidae	Stedman (Missouri), 1902
	Corn	*Tipula paludosa*	Rennie (England), 1917
	Corn	*Tipula* sp.	Kirk (New Zealand), 1895
	Barley	*Tipula paludosa*	Lind, Rostrup, and Kolpin Ravn (Denmark), 1915
	Barley	*Tipula* sp.	Wahl and Müller (Germany), 1914
	Barley	*Tipula oleracea*	Goriatchkovsky (Russia), 1915
	Oats	*Tipula paludosa*	Lind, Rostrup, and Kolpin Ravn (Denmark), 1914, 1915
	Rice	*Tipula oleracea*	Del Guercio (Italy), 1914
	Rice	*Tipula parva*	Onuki (Japan), 1905
	Cereals	*Tipula oleracea*	Anonymous reference (Ireland), 1904b
	Cereals	*Nephrotoma pratensis*	Hollrung (Germany), 1898

Family	Crop	Species	Authority
Gramineae.....	Meadows and pastures.....	*Tipula bicornis*.....	Forbes (Illinois), 1890
	Meadows and pastures.....	*Tipula simplex*.....	Carnes and Newcomer (California), 1912
	Meadows and pastures.....	*Tipula oleracea*.....	Anonymous reference (Ireland), 1904 b
	Meadows and pastures.....	*Tipula oleracea*.....	Désoil (France), 1914
	Meadows and pastures.....	*Tipula paludosa*.....	Rennie (England), 1917
	Meadows and pastures.....	*Tipula* sp.....	MacDougall (Scotland), 1915
	Meadows and pastures.....	*Tipula* sp.....	Ritzema Bos (Holland), 1915
	Meadows and pastures.....	*Tipula* sp.....	Marchal and Prillieux (France), 1916
	Meadows and pastures.....	*Tipula oleracea*.....	Ormerod (England), 1885, 1883, 1900
iliaceae.....	Tulips (bulbs)..	*Nephrotoma maculcta*.	Collinge (England), 1911
	Onions and garlic.....	*Tipula oleracea*.....	Vassiliev (Russia), 1915
ruciferae.....	Cabbage.....	*Tipula oleracea*.....	Schoyen (Norway), 1903
	Cabbage.....	*Tipula oleracea*.....	Averin (Russia), 1913
	Cabbage.....	*Tipula oleracea*.....	Goriatchkovsky (Russia), 1915
	Cabbage.....	*Tipula* sp.....	Lutchnik (Russia), 1916
	Cabbage.....	*Nephrotoma* sp.....	Lutchnik (Russia), 1916
olygonaceae....	Buckwheat....	*Tipula oleracea*.....	Goriatchkovsky (Russia), 1915
osaceae.....	Roses.....	*Nephrotoma lineata*...	Schaufuss (Germany), 1901
	Raspberry and strawberry...	*Tipula oleracea*.....	Barthou (France), 1913
eguminosae....	Clover.....	*Tipula bicornis*.....	Webster (Indiana), 1892a
	Clover.....	*Tipula bicornis*.....	Forbes (Illinois), 1890
	Clover.....	*Tipula flavolineata*....	Sopotzko (Russia), 1916
	Clover.....	*Tipula oleracea*.....	Del Guercio (Italy), 1914
	Japan clover...	*Tipula cunctans*.....	Hyslop (Tennessee), 1910
	Alfalfa.....	*Tipula simplex*.....	Carnes and Newcomer (California), 1912
	Peas.....	*Tipula paludosa*.....	Lind, Rostrup, and Kolpin Ravn (Denmark), 1914
mbelliferae....	Carrots.....	Tipulidae.....	Lesne (France), 1905
olanaceae.....	Potatoes.....	*Tipula oleracea*.....	Beling (Germany), 1887
	Potatoes.....	*Tipula lateralis*.....	Cameron (Scotland), 1917
	Potatoes, stored	Trichocera.....	Johannsen (Maine), 1910
	Potatoes, stored	Trichocera.....	Carpenter (Ireland), 1912
Compositae.....	Cardoon.....	*Tipula* sp.....	Lesne (France), 1908

Species affecting woody plants

Species that injure or destroy living trees or shrubs are not common, and the damage that they do is almost entirely of a minor nature.

Ctenophora angustipennis is recorded as doing secondary damage to prune trees in Oregon (Lovett, 1915). Fuchs (1900) records four species — *Tipula scripta*, *T. marginata*, *Nephrotoma cornicina* [as *iridicolor*], and *N. quadrifaria* — as injuring young plants of both deciduous and coniferous species. Taschenberg (1880:54) describes *Tipula flavolineata* and *Nephrotoma crocata* as destroying year-old seedlings of fir and larch. Matsumura (1916:466) records the larva of *Nephrotoma makiella* as injurious to the mulberry (Morus) in Formosa.

METHODS OF EXPERIMENTAL PROCEDURE

Collecting

The larvae of the larger species of crane-flies, such as those of the genera Tipula, Pedicia, and Eriocera, may be readily discovered in the field but the immature stages of the smaller Tipulidae are not so easily found. It is necessary to bring into the laboratory large quantities of the material in which the immature stages are supposed to be living, and there to examine it with considerable care. In the case of mud or earth, it is better to wash away the finer silt particles and examine the residue. The writer has found it most convenient to use a Simplex water-net, placing in it a handful of earth and holding it underneath a running faucet. The mesh of this net is of sufficient diameter to retain any crane-fly larvae except the very young stages. When the fine particles have been removed the residue can be examined in water in white enameled or porcelain dishes, and the larvae and pupae may be easily detected in the water. Numerous associated forms of life will be found, and these should be preserved or recorded.

The immature stages of wood-inhabiting species are most easily found in the field by a patient and painstaking examination of the removed bark and the exposed parts of the tree stump or trunk. Moss-inhabiting species, such as those of Liogma and many tipuline forms, may be shaken from their haunts onto a piece of white oilcloth, where they are easily observed.

Killing and preserving

The larvae and pupae to be studied should be dropped into boiling water for a brief instant. The larva, on contact with the water, at once expands to its maximum size, the spiracular disk is spread wide open, and the ana

gills are completely everted. The specimens should be placed in 4-per-cent formalin or, preferably, 70- to 75-per-cent alcohol. Large, fleshy larvae, such as those of the Tipulinae, should be slit at the third or the fourth abdominal segment to allow easy penetration of the preservative. Other notes on preserving material are given by Banks (1909) and by Williamson (1916).

Study

In the study of the gross material, both the binocular and the compound microscope may be used. A special word on the preparation of the head capsule of the larva may be helpful. In removing the head capsule from the body it is generally easiest to slit longitudinally the thoracic segments back of the head and pull the capsule thru this incision. In forms with compact and massive capsules, the thorax and the head may be snipped off and the head everted after the manner of turning the finger of a glove. The capsule should be left in a 5-per-cent solution of caustic potash until all the fleshy parts have been removed. It should be dissected out so that all the mouth parts are isolated and rendered distinct for study. Then follow the usual processes of washing and dehydration, and the final mounting in canada balsam.

Various means are available for examining the spiracular disk. The specimen may be placed in a watch crystal under water and held firmly in place by a piece of glass, as, for example, a broken microscope slide. By holding a heavy piece of glass over the anterior end of the body, the posterior end may be bent at a right angle and bolstered in place by two or three other glass fragments so that the disk is directed straight upward and its details are easily examined. Other methods, such as embedding the anterior end of the larva in paraffin in a deep dish and submerging the body, may be followed. It must be emphasized that in alcoholic gross material the study should be conducted under alcohol or water.

The measurements of the pupa — abbreviated in the text as *d.-s.* (dextro-sinistral) for the width and *d.-v.* (dorso-ventral) for the depth — are taken opposite the wing pad.

Rearing

In order to rear the immature stages of crane-flies successfully the natural haunts should be imitated as closely as possible. In the case of wood-inhabiting species, large pieces of the material in which the larvae

are working may be brought into the laboratory and placed in the breed ing cages. This method may be followed with species of Tanypter Ctenophora, and other genera.

Fungicolous species, as a rule, also are easily reared. The entire fungu in which the specimen is found should be brought into the laborator and placed in a jar on a bed of clean sand. The sand takes up the liquid produced by the disintegration of the fungus and provides a place f pupation. Species of Limnobia, Ula, and other forms are reared in th manner.

The chances for error in rearing are many. One must be certain th there are no other larvae in the breeding jar with the one that is bein reared; else one of these other larvae might transform and emerge firs and the results would be altogether misleading. The writer has ha this happen in his breeding cages, even after the utmost care had bee used to guard against it. Beling, the great German student of th immature stages of crane-flies, made a few mistakes in the same way as, for example, in the case of his Trimicra, the larvae that he describ being pediciine and probably a species of Dicranota or the young larva of a Tricyphona. What happened, presumably, was that Beling foun these pediciine larvae and placed them in rearing; in the same cage, b unknown to the breeder, was a larva of Trimicra which emerged, an naturally Beling thought it came from one of the larvae that he ha placed in rearing. It is usually easy to check up such errors. Thu the writer has placed in rearing the larvae of Penthoptera and, to h surprise, had adults of *Limnophila adusta* emerge. Obviously larva of *L. adusta* got into the cage in spite of precautions, and emerged firs When closely related species are concerned, however, it becomes a ha matter to straighten the tangle. Hence a species cannot be reared t many times, since each rearing checks up the previous results.

The precaution to be taken in the case of mud-inhabiting or san inhabiting species is to see that the mud or sand is baked or thoro desiccated in order to destroy all life in it. Then it may be remoistene and the larva or larvae chosen to rear may be put into the earth witho the chance that some unknown larva may be lurking in the medium an may emerge first, and so bring about confusion.

The writer has found that the most satisfactory way to rear sma tipulid larvae found in earth or sand is to place a small amount of bak

earth from their haunts in a 4- or 6-dram shell vial, moisten the earth, and place a thin layer of moss over it. The vial should not be corked, but should be covered with a piece of cheesecloth held in place by rubber bands. In the case of carnivorous species, as the Hexatomini and the Pediciini, individuals should be isolated in vials, but the herbivorous species may be bred in large numbers in single containers. The predatory forms are usually distinguished without difficulty by their extremely active, snakelike motions, the other species being more sluggish in their actions.

Strictly aquatic forms, such as Antocha, are reared only with great difficulty. These species can survive only in rapidly flowing, well-aërated water, and it is usually a difficult matter to imitate this condition successfully. The best plan is to place rearing cages in the natural haunts of the larvae. This can be done if a suitable location is sufficiently close at hand and free from disturbance by inquisitive passers-by. The chief source of danger to breeding cages in natural streams is that a sudden rise of water may suffocate the larvae or wash the cages downstream, or else may destroy the contents of the cage by a thick deposition of silt. Lotic species that are discovered in streams far removed from the laboratory can be transported alive for long distances in folds of wet cheesecloth. The writer has found this to be the most satisfactory way to keep advanced pupae alive until they are ready to emerge as adults.

In general, the writer has found species of the tribe Pediciini the most difficult to rear, and the Limnobiini and the Eriopterini perhaps the easiest. Mud-inhabiting species are easily reared, but species from rushing torrents are at the opposite extreme and it is almost an impossibility to bring some of these species thru to the adult condition.

TYPES OF THE IMMATURE STAGES

The material on which this study is based was almost entirely reared. It seems desirable that these authentic specimens of the larva and the pupa should be so designated that they will have a value greater than that possessed by ordinary specimens. No terms for the designation of types of the immature stages are known to the writer, and the two that are needed in this paper are here defined as follows:

Nepionotype, The type of the larva.
Neanotype, The type of the pupa.

The type specimen should, of course, be selected only when there is absolute certainty of the identification, and in most cases this determination can be made only by rearing the species. After the species has been reared (this should be done many times, if possible, in order to check up the identity), a good representative specimen may be chosen as the type of the stage. In the cases in which the species is known only from a single specimen, the nepionotype may be the larval skin, the neanotype the pupal skin. The remaining specimens of the original series become paratypes. The types of the immature stages possess fully the value of the type of the adult and should be as carefully preserved. The types herein designated are in the collection of the writer. They are preserved in alcohol, but the larval heads of most species have been removed, treated with caustic potash, and mounted in balsam.

EXTERNAL MORPHOLOGY

The larvae and the pupae of crane-flies show considerable diversity in their general form. The fundamental plan of structure remains much the same thruout the group, but the details are widely different and furnish the characters in use for the separation of the various tribes and lesser divisions.

The immature stages of crane-flies have evolved more rapidly than have the adult flies, and in many features they show a greater specialization. The head capsule of the larva seems to be the most constant feature, the same fundamental type of structure recurring in the generalized members of all the various groups, indicating a close phylogenetic relationship. On the other hand, the respiratory organs of both the larvae and the pupae vary greatly in the different species and are obviously molded by habitat. The often-repeated statement that the inside of an organism shows what it is, while the outside shows where it has been, is well illustrated here.

The larva

General features

The form of the larval body is, as a rule, moderately elongated and usually terete. The head is eucephalous and non-retractile in the three families Tanyderidae, Ptychopteridae, and Rhyphidae. It is incomplete and more or less retractile in all the species of Tipulidae. The body is shortest in the more generalized forms, becoming greatly elongated

in many Eriopterini and some Limnobiini (Dicranoptycha). It is made up of the composite head capsule, three thoracic segments, and nine evident abdominal segments. In some species all the abdominal segments are subdivided, respectively, into a narrow basal and a usually broader posterior ring, or annulus; in other species only the basal segments are so subdivided. The integument is usually covered with a dense appressed pubescence and often bears setae, or pencils of hairs, or, in some Cylindrotominae, spinous projections.

Respiration is characteristically metapneustic; in the Rhyphidae it is amphipneustic, in Antocha apneustic. The typical metapneustic forms often show vestigial lateral spiracles, but these are not functional in any species known to the writer and the peripneustic type of larva is still unknown in this group of Diptera. The spiracles are placed at the ends of the long breathing tubes in the Tanyderidae and the Ptychopteridae. In the Tanyderidae, the Tipulidae, and the Rhyphidae the disk is surrounded by a varying number of lobes which are rarely indistinct, these ranging in number from two to eight. Anal gills are found in representatives of almost all the major groups of crane-flies, and their loss is a result of habitat and non-usage. In wood-inhabiting species the gills are often modified into blunt lobes, having the evident function of propulsion by shoving.

Body form

As already stated, in the majority of crane-fly larvae the body is terete or approximately so, but in some species it is decidedly depressed with the ventral surface flattened. Such forms are Dactylolabis, some Cylindrotominae, and some Tipulinae. The integument is produced into elongate spines and blades in almost all species of Cylindrotominae, similar conditions being suggested in a few tipulines. A definite arrangement of setae (chaetotaxy) obtains. The basal abdominal ring is provided with a transverse creeping-welt in the Limnobiini and in some Hexatomini and Pediciini, as well as in a few other forms. In some genera, as Epiphragma, this welt is practically naked; in others it is covered with a microscopic scurfiness; while in still others (Dicranota) it is separated into distinct paired prolegs, which are armed with circlets of chitinized hooks that lessen in size from the tips basally. The welts are both dorsal and ventral in position in many Limnobiini and in some Pediciini (Rhaphi-

dolabina), or are ventral only (Rhamphidaria, Ularia, Epiphragmaria, and most Pediciini). In number they range from four (on abdominal segments 4 to 7) in most Pediciini, to five or six (on abdominal segments 2 to 7) in Ularia, Epiphragmaria, and other forms.

Organs of respiration

The spiracular disk.— The posterior end of the body is usually truncated, bearing the two spiracles and surrounded by a number of fleshy lobes. These lobes vary much in their shape and armature, and range in number from two in the Pedicaria and the Antocharia to six or eight in the Tipulinae. The inner faces of the lobes are often lined with brown or black horny plates, which serve as points of attachment for the longitudinal muscles. Their arrangement and distribution are of great service in specific classification.

The Limnobaria usually have the lobes surrounding the spiracular disk indistinct; the Antocharia have two long ventral lobes; the Rhamphidaria five lobes; the Ellipteraria and the Dicranoptycharia four lobes.

In the Eriopterini, the Elephantomyaria and some Eriopteraria have four lobes; the majority of species of the latter division have five. In these last-named species the disk is almost squarely truncated, and the five lobes are subequal and stellate in appearance.

The Hexatomini usually have four lobes, with the ventral pair longer than the lateral pair. In a few cases only (Ularia, Dicranophragma, Poecilostola), a reduced mid-dorsal lobe is present. In the more specialized forms the lateral lobes also tend to reduce, simultaneously with the elongation of the ventral lobes. In this tribe the disk is fringed with long hairs, which are sometimes excessively elongate, especially on the ventral lobes where they appear as long fringes of delicate hairs that spread out on the surface film of the water as broad fans. Such fringes are found in a large number of Hexatomini and also in the Adelphomyaria (supposition). Near the tips of the ventral lobes, but inside this fringe of hairs, are often inserted one or more stiff sensory bristles.

In the Pediciini, the Pedicaria have two lobes and the Adelphomyaria (supposition) have four. In the former division the lobes are ventral in position and are almost naked.

The Cylindrotominae have six rather indistinct lobes in Cylindrotoma, and four in the other genera.

The Tipulinae show six lobes in practically all genera, the only exceptions being that there are eight in a few rare cases of Tipula and five in Dolichopeza, and that lobes are indistinct or lacking in Tanyptera.

In the Rhyphidae (Trichocerinae) the spiracular disk is very similar to that in many Tipulidae, and is surrounded by four lobes. In the Ptychopteridae the very reduced disk is borne at the tip of a slender, retractile breathing tube. In the Tanyderidae the condition is somewhat similar, but here the disk is larger and is surrounded by five lobes at the tip of a long, stout, non-retractile breathing tube.

The spiracles vary greatly in size from very large to small and vestigial, or they may even be lacking in some species of Antocha. They consist of an apparently uniform middle piece surrounded by a radially folded margin, or ring, of various widths, called the *stigmal ring*. Many authors (De Meijere, Mik, Müggenberg, Brown, Keilin, and others) hold that the middle piece is an imperforate chitinized plate and that respiration takes place thru the stigmal ring. Gerbig (1913), however, shows that the middle piece is split across the disk, the cleft being closed by two overlapping membranes. Directly behind the spiracles the tracheae enlarge into the felt chamber, whose walls are provided with long, branched, reelike structures, the branches apparently anastomosing. Surrounding the felt chamber in many larvae are dense masses of air tubes, which make up the tracheal lungs. These tubes are arranged in bundles, which arise in special cavities of the felt chamber; thus, in *Tipula paludosa*, there are about fifty bundles, each of about twenty tubules, making a total of one thousand of these air canals (Gerbig).

The early stages of the larva are quite different from the later developmental stages, as Gerbig (1913:137–140), working on *Tipula paludosa*, has well shown. The prominent six-lobed spiracular disk of the more mature larva is represented in the first developmental stage by four heavily chitinized projections, which bear but few bristles on their outer margin. The dorsal lobes are not evident, but are replaced by eight branched bristles, about equidistant from one another. The spiracles are oval, not circular as in the grown larva, and project a little beyond the level of the disk. The writer has noted several first-stage larvae with an appearance almost as described but showing several points of difference. The immature larvae of Phalacrocera are described elsewhere in this work (page 963).

Anal gills.— In the Ptychopteridae and in the Tanyderidae there is but a single pair of anal tracheal gills. In the former these are very small and are cylindrical, in the latter they are large, branched, fanlike structures. In the Tipulidae the anal gills number from four in most Limnobiinae to six or eight in the Tipulinae. The increase in number is brought about by a division of the original gill of each side. In generalized forms as Antocha, Pedicia, and others, the anal gills are constricted into segments the apical ones being more or less telescopic into the preceding ones. As a rule the anal gills are entirely or almost entirely retractile within the body.

In the Tipulinae the gills vary with the genera, being blunt and constructed for propulsion in the wood-inhabiting species, such as those of Ctenophora, Tanyptera, Tipula, and other genera. In the semi-aquatic species of Tipula the number of gills varies from four to eight. In the latter case each of the four principal gills is deeply bifid and the gills are arranged transversely, as in *T. ignobilis*; in species with six gills the posterior branches of the posterior gills are atrophied as a rule; in other species which have but four gills, the four anterior branches are preserved, the posterior pair being usually atrophied. In Longurio and Aeshnasoma the four anal gills are pinnately branched, each with about six lateral branches. A similar condition is found in the Tanyderidae.

The head

The primitive crane-fly head was undoubtedly of the eucephalous non-retractile type, as found in the Ptychopteridae, the Rhyphidae, and other families. The retracted head capsule of the Tipulidae is a derived condition.

The massive, compact capsule is found in all of the lower groups of the three subfamilies of the Tipulidae. Such a head is easily derivable from the condition in the Rhyphidae or in the Tanyderidae, for instance. The dorsal median sclerite, the *prefrons*, is almost as large and conspicuous in Ula as in the eucephalous families. The lateral plates that constitute the capsule are shaped like a mussel in the generalized groups, with the posterior incisions shallow. In the more specialized forms, with the capsule greatly dissected, the two plates of either side are entirely separated — the innermost, next to the prefrons, being the *internal-lateral* of De Meijere, and the outermost being his *external-lateral*. The prefron

s found in all forms with the capsule compact and massive, and is even reserved in many species with the dissected capsule. In many cases, owever, it is firmly fused with the internal-lateral plates; or, in some ases, all the plates of the capsule are firmly united and their individual mits are ill-defined. In the generalized forms the clypeus and the abrum are entirely distinct from each other, while in other forms the two ose their individuality by fusion.

The sclerites of the generalized primitive head bear bristles, or setae, f various types and arrangement. In the Tanyderidae the punctures re multisetose; in most Ptychopteridae the setae are branched or some- hat plumose.

The literature on the head capsule and the mouth parts is as follows:

Ptychoptera. De Meijere, 1916:188–191, figs. 14–20.
Bittacomorpha. Hart, 1898 [1895]:192, pl. 5.
Trichocera. De Meijere, 1916:191–194, figs. 21–23.
Limnobia. De Meijere, 1916:198–201.
Dicranomyia. De Meijere, 1916:197–198, figs. 32–35.
Dicranoptycha. Alexander, 1919b:71, figs. 2, 3.
Elliptera. Mik, 1886b:339, pl. 6.
Ula. Alexander, 1915a:5–6, pl. 1.
Dactylolabis. Mik, 1894:261–266, pl. 2; Nowicki, 1867:341 (as Rhicnoptila).
Limnophila. De Meijere, 1916:204–206, figs. 49–51.
Eriocera. Alexander and Lloyd, 1914:21–22, pl. 1.
Hexatoma. Alexander, 1915c:146, pl. 1.
Penthoptera. Alexander, 1915c:155, pl. 1.
Tricyphona. De Meijere, 1916:195–196, figs. 29–31.
Pedicia. Needham, 1903:286, fig. 19.
Dicranota. Miall, 1893:237–238, pl. 10.
Ormosia. De Meijere, 1916:201–204, figs. 37–47.
Gnophomyia. Malloch, 1915–17b:230–231, pl. 34, fig. 10.
Chionea. Brauer, Egger, and Frauenfeld, 1854:614, pl. 11.
Phalacrocera. Miall and Shelford, 1897:344–345; Bengtsson, 1897.
Cylindrotoma. Cameron, 1918.
Liogma. Müggenberg, 1901; Alexander, 1914:111, pl. 1.
Ctenophora. Anthon, 1908:544.
Prionocera. Malloch, 1915–17b:199, pl. 32, figs. 1–3.
Holorusia. Comstock and Kellogg, 1904:55, 61–62.
Tipula. Vimmer, 1906, and 1911:1–6.

In addition to the preceding, the genera Helobia (Beling, Hart, Malloch), Rhaphidolabis (Needham), and Tanyptera have been discussed less fully.

All of the above-named genera are considered in this paper, and the ead capsule and mouth parts of the following genera are described iso: Protoplasa (supposition), Bittacomorphella, Rhipidia, Rhamphidia, ntocha, Epiphragma, Pseudolimnophila, Pilaria, Ulomorpha, Elephant- myia, Teucholabis, Gonomyia, Erioptera, Molophilus, Adelphomyia

(supposition), Rhaphidolabina, Oropeza, Longurio, Aeshnasoma. The descriptions for the genera are either entirely new or else the characters have heretofore been insufficiently described and figured. The details of structure of the head capsules of nearly fifty genera of crane-flies are now known.

The labrum and the epipharynx.— The labrum is preserved in all crane fly larvae. It is usually broadly transverse or oval. The dorsal surface is clothed with short hairs, these being longer on the anterior margin which is often provided also with a limited number of sensory bristles or papillae. The lateral regions on the ventral, or epipharyngeal, side often bear long tufts of hairs. The epipharynx proper is variously armed in the different groups of crane-flies.

The labium.—The labial region of the capsule is of vast importance in classification, and the location of the constituent parts should be early appreciated. The confusion in terminology of the dipterous larval labium has been partly outlined by De Meijere (1916:253). The principal synonyms are as follows:

Submentum.
Mentum — The pharyngeal plate, or lower lip (Meinert); submentum (Miall); ectolabium (Bengtsson); labial plate.
Prementum — Mentum (Miall); ectolabium (Keilin); endolabium (Holmgren, Vimmer Bengtsson).
Hypopharynx — Labium (Meinert); mentum (Miall, in Dicranota); endolabium (Keilin)

The submentum is represented by a narrow transverse strip in the eucephalous groups of crane-flies, being well shown in Ptychoptera. The mentum is the usually chitinized anterior-ventral plate of the capsule. In Ptychoptera it is margined anteriorly with about twenty comblike teeth. In Bittacomorpha it is more or less distinctly bilobed, but is untoothed. In the generalized Tipulidae it is indistinctly divided into an outer plate and, immediately dorsad of this and closely applied to or fused with it, an inner plate. The outer plate furnishes the apical median tooth of the mentum and in some cases an additional tooth on either side. The inner plate adds a varying number of teeth to the mental plate, from two in Epiphragma to as many as ten or twelve in some species of Limnobia. The chitinized plate is completely divided medially in some Eriopterini (Molophilus and some Erioptera), in the Pediciini, and in some Hexatomini (Pseudolimnophila). In this case, each half is

irectly continuous with the ventral bars of the head capsule. In the imnophilaria the mentum is represented by a narrow, transverse, hitinized bar, which is delicately grooved with parallel lines. The ientum is lacking in chitinized parts, or apparently so, in many Eriop-erini and in the higher Hexatomini.

Directly behind the mentum is the prementum, rarely prominent and earing the two small palpi when they are preserved, as in the Ptychopter-dae. The hypopharynx lies immediately dorsad of the prementum. In he Ptychopteridae this is an enlarged, two-horned, fleshy lobe which s difficult to study. In the Tipulidae the generalized condition, such s occurs in the Limnobiini and the lower Hexatomini, consists of two ollar-like chitinized plates whose anterior margins bear from ten to fteen or more teeth. In the Tipulini this plate is narrow, with the nterior margin few-toothed, there usually being five or in some cases ix teeth. In the Pediciini the hypopharynx is labriform; in many 'riopterini it is cushion-shaped and covered with numerous blunt setae.

The antennae.— The antennae are borne on the anterior lateral margin the capsule, laterad of the labrum. They are one- or two-segmented, nd in most cases have one or more apical papillae. De Meijere and hers hold that the principal apical papilla constitutes an additional ntennal segment. In some cases, however, as in Ula for example, two even more papillae are found which are very similar to one another cept for slight degrees of size. It is difficult in such cases to hold any ne of these papillae as a true segment. The writer prefers to consider em as apical sensory papillae, and they are so treated in this paper.

The primitive antennae are not greatly elongated, and are usually ort-cylindrical or subglobular (Ula). An auditory plate, circular in tline and lying on the face of the basal segment, is almost always present. he apical papilla in the Limnophilaria and the Eriopterini is egg-shaped, oval, and is delicately sculptured by a network of apparently impressed nes. In many species, as for example those of the higher Hexatomini, e apical papillae are very long, tapering to the tips. In many Limno-ini, as for example Limnobia, and in many species of Tipula and related rms, the apical papilla is button-shaped, or disklike, and is often very duced.

The mandible.— In the primitive type, such as occurs in the eucephalous oups and in the generalized Tipulidae, the mandible is rather com-

plicated, usually having a considerable number of teeth on the cuttin edge and a distinct sub-basal arm (prostheca) or prosthecal tuft of hair At the same time there are usually one or more setae on the outside the mandible, near the "heel," or base, of the scrobal region. In th generalized tipulid type there are two apical teeth and two rows of cuttin teeth. In other cases, as in the Limnobiini, there are but a single dors tooth, a single apical tooth, and a varying number of cutting teeth the ventral face; in some species of Limnobia the number of teeth in th ventral cutting row is six or seven. In the Tipulini the mandible is ofte reduced in size (as in Tanyptera), there being but a single dorsal an a single ventral tooth in addition to the apical point; the prosthec however, is usually well developed. In the Eriopterini but one row teeth, the ventral, is strongly developed. In the Pediciini and the high Hexatomini, the mandible is elongate and sickle-shaped, with the fe teeth on the cutting edge at about midlength. In Ulomorpha the mandibl is hinged at about midlength, the basal part being hollowed out on th inner face to receive the blade in a position of rest.

The maxillae.— The maxillae are usually of simple form. In th generalized types, such as the eucephalous families and the lower group of the subfamilies of Tipulidae, they consist of a large and distinct trans versely triangular cardo, a conspicuous stipes, and distinct inner an outer apical lobes. In the Pediciini the lobes are separate in the suppose Adelphomyia larva but are fused together in the highest types (Dicranota In the Hexatomini the lobes are reduced to a single long, flattened blad The outer and inner lobes are usually densely hairy, especially at the t and on the inner face of the latter. The palpus is uni-articulate an antenniform in the generalized forms, is short-cylindrical with a varyin number of tiny sense pegs at the apex, and bears on its face a circul auditory plate similar to that of the antenna. The armature of the inn lobes is varied, in some species being provided with stiff, comblike seta or projections.

The pupa

General features

The pupa of the crane-fly is of the so-called "free," or "mummy, type. In only a few cases does the larval skin adhere to the end of th abdomen (Dactylolabis, Cylindrotoma, and some other forms.) The hea is usually small, and is ventral in position. Immediately behind th

head on the pronotum are the two breathing horns, which are variously developed in the different tribes and genera and furnish invaluable bases for classification. The leg sheaths usually far exceed the short or but moderately elongate wing sheaths. The abdominal segments are often provided with a subterminal armature of stiff setae, or spines. At the posterior end of the body, the last two segments (cauda) are variously modified to inclose the sexual organs of the adult flies.

The head

The head is usually small and flattened, occupying the anterior ventral part of the body. The eyes differ in size in the various groups, in some (Erioptera, Elephantomyia) being larger in the male than in the female; in the male sex they are approximated on the median line above or beneath.

The front between the eyes is usually narrowed behind, delimited by the inner margin of the compound eye, narrowed at the posterior end, and bluntly rounded or pointed at the apex. This part is described herein as the *labrum*, or *labral sheath*. It contains the fronto-clypeus and the labrum of the imago. At its tip it bears two more or less divergent lobes, these being in some cases closely approximated so as to appear as a single lobe; these are herein termed the *labial lobes* or *sheaths*, and they contain the so-called paraglossae of the adult fly.

On either side of the labral sheath, and usually divergent and lying along the posterior margin of its face, are the sheaths of the maxillary palpi, which in most cases extend beyond the knee joint of the fore legs. In almost all the Limnobiinae these are short and stout and almost straight, but in the majority of the tipuline forms they are curved at their tips, which in most species are actually recurved and offer an easy means of distinguishing members of this subfamily. In many of the Limnobiini the margins of the cheeks project as flattened ledges overlying the joint of the fore legs.

The antennae arise from above or between the eyes and bend laterad and thence caudad around the eyes, in some forms, such as Elephantomyia and the males of other species, lying across the face of the eyes. The antennae usually end just beyond the roots of the wings, but in the males of some species (Eriocera) they extend beyond the tips of the wings. The basal segments (scape) of the antennal sheath are often armed with

spines or tubercles, and very often the organ is angulated at the end of each segment of the adult antenna inside.

At its vertex, between or just dorsad of the antennal bases, the head may bear a crest which is usually bilobed and setiferous. In some species this cephalic crest is quadrituberculate, there being a smaller secondary crest behind or before the primary one. In the Tipulini the crest is very inconspicuous and but weakly setiferous. In most of the Limnobiini it is lacking or nearly so.

The head may be variously armed with spines, tubercles, or setae; in *Eriocera spinosa*, for example, there are spines or strong tubercles on the antennal scape, on the clypeal region, and even on the face of the eye. In some cases there are setae on the front between the eyes, on the clypeus, and on the cheek.

The thorax

The pronotum of the thorax is small. The ventral part is closely applied to the head and often has small setiferous tubercles close to the breathing horns. The pronotal breathing horns are variously developed in the different tribes and genera, and are discussed here in general terms only.

Many species are propneustic, the pronotal horns alone being functional. Other species (in Hexatomini and Eriopterini) are peripneustic, the second to the seventh abdominal segments being provided with functional lateral spiracles in addition to the breathing horns; other pupae have lateral abdominal spiracles, but in most cases they are merely vestigial. Some pupae are amphipneustic, there being in addition to the breathing horns a conspicuous pair of spiracles on the dorsum of the eighth abdominal segment (Rhamphidia, Ula, Epiphragma; in the typical species of Limnobia these are present but they are small and are probably nonfunctional).

In the Ptychopteridae the breathing horns are very unequally developed, one being enormously elongated and filiform while the other is abortive. In some Tipulini (Longurio, Prionocera, Tipulodina) the horns are likewise greatly elongated, but in these cases they are shorter than the body and are approximately subequal in size, or at least are not so disproportionately unequal.

In the Limnobiini the breathing horns are usually stout and broad, in the typical Limnobaria (Limnobia, Dicranomyia) being subquadrate,

ubcircular, or even broader than long. In Elliptera they are earlike and ery large. In Antocha a unique condition is found, in that the apparatus s divided into eight stout filaments. In the Eriopterini and the Hexatomini he horns are usually long and cylindrical or slightly flattened, and straight r but slightly curved. There are numerous deviations from type, however. In Gnophomyia and some species of Gonomyia (*alexanderi* and *ransensis*, for example), the horns are trumpet-shaped; in *Gonomyia sulphurella* they are compressed and flattened into fanlike structures. In several widely separated paludicolous genera, such as Ulomorpha, Pseudolimnophila, and Prionocera, the breathing horns are split at their tips nto two conspicuous flaps with fimbriate margins, an obvious adaptation o an existence in mud. Often the breathing horns are very small (as in Elephantomyia, Teucholabis, and Trichocera) or even microscopic Dicranoptycha). *Limnophila hyalipennis* (Zett.) is described by Beling 1886:198–199) as lacking the breathing horns, but this is presumably an rror of observation which may be due to a defect in the material studied, r possibly the horns are sessile or reduced as in Dicranoptycha. In ome species (Erioptera, Eriocera) the horns are stout at the base but aper rapidly to the acute points. In many Pediciini the tips of the orns are expanded and usually obliquely truncated, with a row of reathing pores around the margin. The tipuline breathing horns are markably uniform in general structure, being usually elongated cylindrical shape, of moderate length, and with the tips slightly expanded. The ost conspicuous deviations from type are the short, flattened, and somehat clavate horns of Tanyptera.

The thoracic mesonotum is very convex, or gibbous in many species Limnobiini and some Hexatomini). In other species it is declivitous, ith a high transverse crest (Eriopterini). This crest may be armed ith numerous small spines (Helobia); from two to four powerful hooks Molophilus, some species of Ormosia, some species of Erioptera, Teucholabis); from six to eight tubercles set with stiff bristles (Gonomyia); or bundant small setiferous tubercles on either side of the median line, hese being less conspicuous along the shoulder (most species of Ormosia and of Erioptera). In *Eriocera longicornis* there is a median pine or tubercle on the scutellum. In some Cylindrotominae the etanotum bears spines. The extreme lateral or ventral margin is roduced into a blunt or somewhat pointed angle just above the wing

root; this is usually armed with from one to three setae. Various othe setae usually occur on the mesonotum.

The leg sheaths lie along the ventral side of the pupa. There is, in th various groups, a considerable difference in the length of the sheaths their position, and the relative arrangement of the ends of the tarsa segments. In the Bittacomorphinae, the fore legs overlie the middl legs. In the Rhyphidae the fore legs overlie the middle pair, which in turn, overlie the hind legs. In the Ptychopterinae and in the Tipulidae all three pairs of sheaths lie parallel along the midventral area, thos of the hind legs being outermost along the wing sheaths, and those o the fore legs being on the inside and contiguous. In Gnophomyia th leg sheaths are very short, extending but little beyond the wing tips an reaching only the end of the second abdominal segment. In other crane flies they are longer, in some species reaching the end of the fifth abdomina segment. Very often the tips of the tarsi are on a level. In the Limno biini the hind tarsi are usually a little shorter, and the fore tarsi are a littl longer, so that the ends of the sheaths form a blunt V. In the Eriopterin the middle legs are usually (except in Gnophomyia) much shorter tha the other legs; in Helobia, moreover, the hind legs are conspicuously longer than the fore legs, so that all three sets end at different levels A somewhat similar and parallel development is found in the tipulin forms.

The wing sheaths are moderately broad, usually ending opposite o a little beyond the apex of the second abdominal segment. The venatio of the various species often shows clearly and with little distortion o the wing pad, and in such cases it is of very great help in locating certai genera. Species with a heavy pattern in the adult wings, such as thos of the genera Discobola and Epiphragma, show this pattern on the win pad in the older pupae, and this helps to confirm their identity.

The abdomen

The abdomen consists of apparently nine segments, the last two bein closely approximated or fused to form the cauda. The segments ar usually plainly divided into a broad dorsal (tergal) and ventral (sternal region, and a much narrower and more restricted lateral (pleural) area The segments beyond the first are variously subdivided into rings, o annuli, by false constrictions, there being usually one, but in some case

two or more, basal rings and a much broader posterior ring. The segments are variously armed with setae, or spines. In the Limnobiini and some Hexatomini these occur on the basal annulus, and consist of a transverse welt which is margined (as in Antocha and Elliptera) or covered with abundant microscopic chitinized points. In some Pediciini the setae occupy both the basal and the posterior rings of the intermediate abdominal segments. In the Eriopterini and most Hexatomini, as well as in the tipuline forms, the setae occur on the posterior ring, just before the caudal margin, and consist of a single transverse row of small spines. In the Cylindrotominae the segments are often armed with prominent elongate body projections (Liogma, Triogma). In Phalacrocera elongate lobes are confined to the posterior segments of the abdomen. In the Ptychopteridae the segments are densely covered with transverse rows of long tubercles which are replaced by chitinized plates near the posterior margin of the segments. In Bittacomorpha these tubercles are stellate at their tips.

The dorsum of the cauda in most crane-flies is armed with four, five, or six conspicuous lobes which are often spinous at or near their tips. These represent the lobes that surround the spiracular disk of the larva, and their number generally corresponds to the larval condition. Thus, in the Ptychopteridae there is a single lobe, in the Pediciini there are two, and in the Hexatomini and the Eriopterini there are four or five. In the Tipulinae there are often but four evident lobes, the dorsal pair of the larva not being represented. In some generalized groups, as the Limnobaria, the Rhamphidaria, and others as indicated elsewhere in this paper, the larval spiracles persist in a more or less functional condition.

Abdominal spiracles.— In the Eriopterini and the Hexatomini there is a distinct and apparently functional spiracle on each pleurite of the second to the seventh abdominal segments, located near the base of the posterior ring. In the Eriopterini these spiracles are small and, in the cast pupal skin, appear tubular or elongate. Smaller vestigial spiracles are evident in most genera of the Tipulidae.

As has been mentioned earlier in this paper, in certain primitive genera of Tipulidae — such as Rhamphidia, Ula, Epiphragma, and to a lesser extent those of Limnobaria — there is a pair of rather large spiracles on the dorsum of the eighth segment. In *Dactylolabis cubitalis* the lateral

abdominal spiracles are protuberant, notably the pair on the second segment.

The genitalia.— The genital sheaths conceal the adult organs within. In the male the valves are usually subequal or the sternal valves are a little the longer. In the female the sheaths, or acidothecae, of the ovipositor usually have the dorsal valves considerably longer than the sternal valves and distinctly upturned at their tips. In the few groups with fleshy ovipositors, the female cauda is very difficult to distinguish from the cauda of the male. The valves are variously armed with spines or lobes, at or before the tips.

INTERNAL MORPHOLOGY

The internal morphology and anatomy of the crane-fly larva are here considered in general terms only. The two genera that have been studied in greatest detail by the writer are Eriocera and Antocha. The most important literature on the various systems of the body is cited in order to make reference to it more easily available.

The digestive system

The most important literature on the digestive system is as follows:

Ptychoptera. Grobben, 1876; Van Gehuchten, 1890.
Chionea. Brauer, Egger, and Frauenfeld, 1854:613–614, pl. 11, fig. 4.
Dicranota. Miall, 1893:242–245.
Phalacrocera. Miall and Shelford, 1897:347–351; Bengtsson, 1897.
Ctenophora. Anthon, 1908:546–551, figs. 12–35.
Holorusia. Kellogg, 1901 a; Comstock and Kellogg, 1904:56–57.

Herbivorous larvae (*Tipula, Holorusia, Ctenophora, Phalacrocera*)

In the larva of herbivorous species the alimentary canal extends the length of the body as an almost straight tube inclosed by the coiled perforated sheets of adipose tissue. The esophagus is slender, opening into the hypopharynx. The proventriculus has a large esophageal invagination at its anterior end. The ventriculus has at its anterior end four elongated ventricular caeca, these being of two distinct lengths in pairs (didynamous) in Ctenophora, and all four alike in Holorusia. In Ctenophora there are four small, pocket-like gastric caeca near the posterior end of the ventriculus, which are not mentioned as occurring in Holorusia. At the juncture of the ventriculus and the small intestine are the four

coiled malpighian tubules. Behind the ventriculus lies the small intestine, with a caliber much smaller than that of the ventriculus. At the union of the large and the small intestine is a prominent diverticulum of very large size (in Ctenophora three times as large as in Holorusia). The large intestine gradually dilates behind to form the rectum.

Phalacrocera has the ventriculus without caeca and the hind intestine without a diverticulum, altho it is decidedly a herbivorous genus. The condition in Chionea is almost the same. In Phalacrocera, and probably in most other larvae, a peritrophic membrane (a secretion of the epithelium which incases the food and keeps it from direct contact with the epithelium) is present.

There are four malpighian tubules in all the Tipulidae that have been thoroly studied (Chionea, Eriocera, Dicranota, Phalacrocera, Ctenophora, Holorusia, Tipula, and a few others). In the Rhyphidae, likewise, there are four tubules in both the larval and adult stages. In the Ptychopteridae, however, there are five tubules, as in the Culicidae, the Psychodidae, and related families. This might indicate some basis for placing the Ptychopteridae in close proximity to the Culicidae, as has been done by Lameere (1906).

The salivary glands consist of two large coiled tubules which pass into a collecting duct and unite to form the common collecting duct that opens at the base of the hypopharynx.

Carnivorous larvae (Dicranota, Eriocera)

The alimentary canal in the carnivorous type of crane-flies is a short, straight tube, with a minimum of appendages such as caeca and diverticula. In Eriocera the esophagus is very long, and the ventriculus is short and without caeca. The malpighian tubules are yellow at their origin, soon passing into an orange-brown color. The intestine is short and straight, without a diverticulum.

The salivary glands in the newly killed larva of *Eriocera spinosa* are very conspicuous by their opalescent color, which persists for a day or more after death. These glands consist of two elongate-oval or cylindrical glands, of the opalescent color just mentioned. From the anterior end of each of these glands passes the long, slender, salivary collecting duct, which unites with its fellow to form a common duct opening at the mouth cavity. From the caudal end of each gland is a flattened, almost hyaline,

elongate lobe which is indistinctly pseudo-segmented, in its posterior part being in intimate connection with the abundant fat tissue.

Respiration and circulation

The most important literature on the respiratory and circulatory organs is as follows:

Ptychoptera. Grobben, 1876.
Dicranota. Miall, 1893:245–248.
Phalacrocera. Miall and Shelford, 1897:351–356.
Liogma. Müggenberg, 1901.
Ctenophora. Anthon, 1908:551–554.
Holorusia. Kellogg, 1901 a; Comstock and Kellogg, 1904:57–58, 60.
Tipula maxima. Brown, 1910.
Tipulinae, Hexatomini (especially *Tipula paludosa* and *Limnophila punctata*). Gerbig, 1913.
General articles. De Meijere, 1895; Viallanes, 1880.

The most important works on the structure of the tracheal system with special reference to the mechanics of the spiracles, are those by Müggenberg (1901), De Meijere (1895, 1902, 1916), Brown (1910), and Gerbig (1913). Miall and Shelford (1897:351–356) discuss in much detail the structure of the heart in Phalacrocera.

In *Eriocera spinosa*, which may be considered as typical for this group of crane-flies, there are two principal tracheal trunks which lie in a dorsal position and run almost the length of the body. They are connected across by a very delicate, unbranched, simple, tracheal commissure, and send off branches laterally to supply the various organs of the body. Near the posterior end of the body they are approximated, and just in front of the spiracles they expand into the tracheal chamber. Directly cephalad of this chamber the first lateral branch passes off, numbering from the posterior end forward. Branches 2 to 8 are large and much forked. Just after leaving the main tracheal trunks, each of these sends off a ventral branch which supplies the alimentary canal and the fat tissue. Branch 3 supplies the region of the malpighian tubules; branch 4, the posterior part of the stomach; branch 5, the anterior part of the stomach; branches 6 to 8, the esophageal region — branch 6 supplying the proventriculus, branch 7 and part of branch 8 the esophagus, and the remainder of branch 8 the pharyngeal region.

The main part of each lateral branch continues laterad, at its first (anterior) fork sending a branch forward to the next branch, so as to

form a complete but much-branched lateral trachea. The branches are very diffuse and abundant and the skin is well supplied. As already stated, the cross-commissures are very delicate and are unbranched or nearly so, the dorsal regions of the body being supplied by branches from the lateral supply.

The condition of the tracheae in Antocha, the only apneustic crane-fly larva among the species here considered, may be outlined as follows:

The usual two principal trunks are present, joined across on each segment by delicate cross-commissures which send off two approximated branches except on the eighth segment. Laterad and ventrad of the principal trunks are the delicate lateral tracheae. These are joined to the main trunks by fine branches inserted about midway between the dorsal commissures, toward the posterior end of the body lying nearer the posterior commissure than the anterior one.

At the ninth segment each trunk sends off a branch from its proximal side, these branches being connected by a long commissure and supplying the posterior pair of gills. The commissure is about as long as that part of the branch between it and the trunk. Immediately caudad of, or just at, the fork, but on the ventral side, a subequal branch passes into the anterior gills; at the same point the delicate lateral tracheal trunk finally ends in the main trunk. Caudad of this triple forking the main trunk gradually widens out into a cylindrical structure which is truncated apically, at the tip passing out into two small elongate branches, near the base with about three delicate branches, two being dorsal in position and one more lateral. All of these tracheae, to the gills and to the caudal lobes, send off many branched capillaries at frequent intervals, and the caudal lobes unquestionably function as tracheal gills.

A comparison of Antocha with Dicranota as described and figured by Miall (1893:245–248) shows, in the latter, distinct spiracles and the gills similar but much smaller. The tracheal arrangement differs in that a single branch on either side supplies both gills of that side, while the caudal lobes are tracheated by a branch that leaves the main trunk close to the spiracles. (Plate XII, 2 and 3.)

The arrangement of the tracheae at the base of the wing pad is described and figured for Bittacomorpha by Dr. Chapman in Comstock's *The Wings of Insects* (1918:36–37).

The nervous system

The most important literature on the nervous system is as follows:

Ptychoptera. Grobben, 1876.
Dicranota. Miall, 1893:241.
Phalacrocera. Miall and Shelford, 1897:356; Bengtsson, 1897.
Ctenophora. Anthon, 1908:556–557.
Holorusia. Comstock and Kellogg, 1904:58–59.

In Holorusia the brain, or supra-esophageal ganglion, is composed of two principal lobes united posteriorly and lying above the esophagus. Beneath the brain and on the under side of the esophagus lies the subesophageal ganglion, which is connected with the anterior end of the brain lobe by the circum-esophageal commissures. The above-named organs form a complete ring, or collar, around the alimentary canal. The ventral nervous system leads backward from the subesophageal ganglion on the ventral surface of the body wall. In the thorax there are four closely approximated ganglia representing the thoracic and the first abdominal segments. Beyond these and located in the abdomen are six abdominal ganglia. The ganglia send off four large nerve trunks.

The condition is similar in Ctenophora and in Tipula, there being seven abdominal ganglia, of which the first is located in the thorax and the last six in the abdomen. In Phalacrocera there are eight abdominal ganglia, the first being usually found in the first abdominal segment and the eighth in segment 10. The head ganglia are all independent of one another, not fused into a complex. The longitudinal commissures between the first five ventral ganglia are double, and those between the eight abdominal ganglia are simple (Bengtsson). In Dicranota there are likewise eight abdominal ganglia, the first being located in the first abdominal segment and the others in segments 5 to 10, there being two close together in the tenth segment.

The reproductive system

The most important literature on the reproductive system is as follows:

Ptychoptera. Grobben, 1876.
Dicranota. Miall, 1893:248.
Phalacrocera. Miall and Shelford, 1897:356–357.
Holorusia. Comstock and Kellogg, 1904:58.

The reproductive organs appear early in the larval development. In Dicranota the testes lie in the ninth segment and form elongate capsules,

when sufficiently advanced giving off the vasa deferentia from the inner side of the hinder end. Even in larvae not fully matured, Miall found ripe spermatazoa mixed with spermatoblasts. No division of the testes into follicles is apparent. In Phalacrocera, also, ripe spermatazoa may be found in the older larvae.

In Phalacrocera the ovaries form a pair of cylindrical bodies tapering to each end, lying on either side of the beginning of the intestine. The ovaries are very peculiar in structure, seeming to be adapted to the almost simultaneous discharge of all the eggs.

The muscular system

The most important literature on the muscular system is as follows:

Body musculation

Ptychoptera. Grobben, 1876.
Dicranota. Miall, 1893:241.
Ctenophora. Anthon, 1908:545.
Holorusia. Comstock and Kellogg, 1904:59–60.

Musculation of the mouth parts

Phalacrocera. Bengtsson, 1897.

The fat bodies, or adipose tissue

The most important literature on the adipose tissue is as follows:

Dicranota. Miall, 1893:241–242.
Ctenophora. Anthon, 1908:554.
Holorusia. Comstock and Kellogg, 1904:56.

The imaginal disks, or histoblasts

The most important literature on the imaginal disks is as follows:

Phalacrocera. Miall and Shelford, 1897:357–358.
Ctenophora. Anthon, 1908:555.
Holorusia. Kellogg, 1901 b; Comstock and Kellogg, 1904:61.

PHYLOGENY

The origin and phylogenetic development of the various groups of crane-flies is still largely problematical. The evidence supplied by the adult flies of the most generalized living groups points to an ancestor which in many respects resembled the recent Mecoptera, or scorpion

flies. That this resemblance is presumably not fundamental is suggested by the immature stages of these same generalized forms, which show but few features that can be reconciled with those of a panorpid-like ancestor. Unfortunately the fossil record helps but little. At the beginning of the Tertiaries, crane-flies were already numerous both in species and in individuals, but in most cases they are clearly referable to existing genera. It is evident, then, that the investigator must go still further back for his evidence, and the fossil crane-flies of the Upper Mesozoic are, unfortunately, still largely unavailable. The phylogenetic development of the group may be considered from two standpoints, the geological record and comparative morphology.

THE GEOLOGICAL RECORD

The most important works on fossil crane-flies are those of Loew (1850), Scudder (1894), Handlirsch (1906–08, and 1910, a and b), Meunier (1906), and Cockerell (1910, 1913, 1916, and 1917, a and b). The writer is indebted to Professor Cockerell for assistance in determining the age of many of the fossil-bearing beds. Excellent accounts of the various deposits may be found in Cockerell (1913) and in Tillyard (1917).

The Tipuloidea, representing the superfamily of crane-flies, is herein considered as being constituted of six families, of which two, the Eoptychopteridae and the Architipulidae, did not survive the Mesozoic period. The Eoptychopteridae are known only from the Mecklenburg Lias (lowest Jurassic), and include but three monotypic genera. The Architipulidae are known from the same formation and include eight species arranged in three genera. The other four families contain recent forms and are included in this paper.

The North American Eocene and Miocene, as represented by the White River and Green River beds and the Florissant shales, respectively, give evidence of having had a northern fauna, especially in the Eocene. This is well shown by the great development of the Cylindrotominae, which in the White River basin almost dominated the crane-fly fauna during the Eocene. It seems probable, moreover, that the group was forced into colder regions of the globe during the Oligocene, when the tropical element reached far to the north. No group of crane-flies that can be considered as being tropical has yet been found in the Florissant. On the other hand, the European Oligocene, as shown by the Gurnet Bay beds

nd the lower Oligocene Baltic amber, has a considerable tropical element pparent — as, for instance, Styringomyia, found in both formations, nd Trentepohlia, Polymera, and Brachypremna, the last two being mber records. In connection with these two last-named genera, as ossils known only from the Baltic amber, it should be noted that each s found living to-day only in America, where they are confined to the ustral and tropical regions.

The Tanyderidae are represented by the Oligocene Macrochile (amber) nd Etoptychoptera. At present this is still a very small group, including ut two genera and nine species.

The Ptychopteridae include a Ptychoptera from the Bohemian Krot-nsee (probably upper Oligocene) and a Bittacomorpha from the lorissant.

The Rhyphidae (Trichocerinae) are represented by two species from e Baltic amber and one or two additional species from the Miocene.

The Tipulidae may be considered in general terms only. But one pulid is listed by Handlirsch as being known from the Mesozoic. In e earliest Tertiaries, however, a variety of species is found in this family hich almost parallels their recent development.

The Limnobiini first appeared in the Eocene (Dicranomyia, Gera-myia). In the lower Oligocene, numerous species of Dicranomyia and ipidia occurred. In the Miocene, Dicranomyia was common, tho obably not so rich in species as at present. Rhamphidia is found in ber, and Antocha has been described from the Florissant Miocene by udder; the latter record, however, seems very doubtful to the writer, dging from Scudder's figure and description.

The Hexatomini are represented by Ula, Limnophila, Eriocera, and lymera in amber, and by Limnophila in the Florissant shales.

There is no record of the Pediciini being preserved as fossils.

The Eriopterini are well represented in the Baltic amber by Erioptera, iophomyia, Gonomyia, and related genera, and also in the Miocene by nomyia, Cladura, and others. Toxorhina, an apparent relative of ephantomyia, occurs in the Baltic amber.

The Styringomyiini are represented by the only living genus, Styringo-yia, a fly of uncertain affinities, in the Gurnet Bay Oligocene (Cockerell, 17c and 1919) and in amber, reappearing in the Pleistocene African pal.

The dominance of the Cylindrotominae (genus Cyttaromyia) in the Eocene and Miocene of the North American fauna has already been mentioned. No records of this group from the European Oligocene are available. The recent species of the subfamily are practically all forms belonging to cold, temperate regions, the few Oriental species of Stibadocera coming from mountains at considerable altitudes.

The Tipulinae have been found as far back as the Mesozoic, but the records are not entirely satisfactory. In the lowermost Tertiaries, however, undoubted tipuline forms occur. Species occur in the Green River shales of Colorado (Eocene). The group was well represented in the Oligocene (Baltic amber, Tulameen beds of British Columbia, Krottensee and Gurnet Bay), and was very common in the Miocene (Radoboj, and especially in the Florissant of Colorado, where some twenty-five species of Tipula and closely allied genera or subgenera have been described by Scudder and Cockerell).

Tipulidae of the Pleistocene are not numerous, only a few having been made known from the refuse of lake dwellings in England (Dicaera apparently related to Ctenophora), and in the African copal, including such genera as Styringomyia, Elephantomyia, and Toxorhina.

COMPARATIVE MORPHOLOGY

The morphology of the various stages of crane-flies has been detailed elsewhere in this paper and need not be repeated here.

PHYLOGENETIC CONSIDERATIONS

The eucephalous families of crane-flies are undoubtedly lower, phylogenetically, than the Tipulidae, and the latter have been derived from the former. The generalized type recurs in all three subfamilies of the Tipulidae, and it is uncertain which of these three should be placed lowermost. Presumably all three groups arose from an immediate common ancestor, or the Tipulinae and the Limnobiinae arose from one point of the tree, the Cylindrotominae developing from the limnobiine stem at a somewhat later period. The accompanying phylogenetic tree (Plate XII, 4) graphically illustrates this apparent evolution of the group. The Limnobiini show but little deviation from the fundamental type. From the level of the lowermost Hexatomini (Ula and Epiphragma), in close proximity to the Limnobiini, the remaining groups of crane-flies can be

derived — the Pediciini and the Eriopterini on the one hand, the hexatomine divisions on the other. The highest levels of development of their respective types are apparently Diotrepha (Limnobiini), Dicranota (Pediciini), Gonomyia (Eriopterini), and Hexatoma (Hexatomini).

The immature stages of the Tipulidae of the antipodal regions (Australia and Chile) are entirely unknown, and their discovery may bring to light striking novelties that may well upset the present ideas of classification. The largest remaining gaps in the present knowledge of the Nearctic fauna relate to the genera Atarba, Toxorhina, Cryptolabis, Phyllolabis, and Megistocera, but it is not expected that any major groups will have to be created for their reception.

LIFE HISTORIES OF CRANE-FLIES, WITH KEYS AND DESCRIPTIONS OF THE SPECIES

Various classifications and arrangements of Diptera have been proposed in the past, and the principal evolutionary changes in the entomologist's conception of classification are herein indicated.

The groupings in the superfamily Tipuloidea have been very diverse. Brauer (1883) separated the eucephalous families from the Tipulidae (Polyneura). Osten Sacken (1893) placed the Tipulidae in the *Nemocera vera*, the Rhyphidae in the *Nemocera anomala*. Coquillett (in Howard, 1912:85–86) included the Tipulidae in his superfamily Tipuloidea, but separated the Rhyphidae, placing the latter in Bibionoidea. Lameere (1906) gave a classification that had little basis in fact, the Rhyphidae being considered by him as Brachycera and the Ptychopteridae being placed with the Culicidae. Knab (1915), working on the respiratory systems of the larvae, demonstrated the hitherto unnatural groupings of the families of the Nemocera, and arranged the crane-fly families, along with a few others, in the group Polyneura, a group coordinate in rank with the previous conception of the Nematocera. The latest grouping, that of Malloch (1915–17 b), was based on a broad knowledge of both the adult flies and the immature stages; and here, for the first time, one gets the true conception of the superfamily limits — the inclusion of the Ptychopteridae, the Tipulidae, and the Rhyphidae in a single major group. Malloch's arrangement is herein adopted, with the following exceptions: (1) the Limnobiidae are not held as constituting a separate family, but are united with the Tipulidae; (2) the family Tanyderidae has been

erected, to include the generalized Tanyderina which have hitherto been placed with the Ptychopteridae.

The immature stages of the four families of the Tipuloidea are readily separable. The larvae of the Tipulidae can be confused only with those of certain low brachycerous forms, as, for example, the Leptidae. In the Brachycera the mandibles work vertically and parallel to each other; in the Nematocera, including the Tipuloidea, they operate transversely or obliquely against the teeth of the mentum and the hypopharynx. The presence of fleshy lobes surrounding the spiracular disk is a character possessed by almost all Tipulidae. The larvae of a few groups of brachycerous Diptera, such as certain Leptidae, Sciomyzidae, and other families, possess entirely similar caudal lobes but are readily recognized by the small and very reduced head capsule.

The eucephalous families of the Tipuloidea may be distinguished by means of the characters indicated in the following keys:

Larvae

1. Body eucephalous, head non-retractile; amphipneustic or metapneustic.....2
   Head incomplete behind, retractile; not amphipneustic.....TIPULIDAE (p. 791)
2. Caudal end of body prolonged into a slender breathing tube; metapneustic.....3
   Caudal end of body not prolonged into a breathing tube; amphipneustic.
   RHYPHIDAE (p. 787)
3. Breathing tube stouter, non-retractile; gills large, pinnately branched; punctures of head multisetose; found in wet decaying wood.....TANYDERIDAE, supp. (p. 769)
   Breathing tube slender, completely or partly retractile; gills slender, cylindrical, unbranched; punctures of head with simple or plumose hairs; found in wet earth.
   PTYCHOPTERIDAE (p. 772)

Pupae

1. One of the pronotal breathing horns greatly elongated, much longer than the body, the other breathing horn very short, abortive. (Family PTYCHOPTERIDAE, p. 772).....2
   Breathing horns short, or, if elongated (some Tipulinae), not longer than the body and the difference in size not so apparent.....3
2. Tarsal sheaths lying side by side, parallel.....**Ptychopterinae** (p. 773)
   The fore tarsal sheaths overlying the middle pair, the four middle and hind tarsi the longest, parallel.....**Bittacomorphinae** (p. 779)
3. Tarsal sheaths overlying one another in pairs.....RHYPHIDAE (p. 787)
   Tarsal sheaths lying side by side.....TIPULIDAE (p. 791)

The pupae of the Tanyderidae are still unknown.

It is possible that Bittacomorphella (page 779) has short breathing horns; in this case this genus would run down to couplet 3 above, but by the arrangement of the tarsal sheaths it runs out as indicated in couplet 2.

FAMILY Tanyderidae

Larva (supposition).— Body eucephalous, metapneustic. Integument smooth, shiny white. Last two segments of abdomen produced into a stout, non-retractile breathing tube, which is distinctly five-lobed at the tip. Tracheal gills two, very large, pinnately branched. Head with scattered punctures, which are multisetose; lateral plates of head united across venter. Mandibles opposed, narrow, tridentate. Maxilla with palpus two-segmented, the outer lobe digitiform, pubescent. Labrum small, semi-circular, with two punctures; clypeus with four punctures.

Pupa.— Unknown.

The Tanyderidae comprise a group of primitive crane-flies including but three recent genera, with ten species. Of these the genus herein considered, Protoplasa, with three known species, is found in the Northern Hemisphere. All that is known concerning the biology of supposed species of this group pertains to *Protoplasa fitchii* and is discussed below.

Genus **Protoplasa** Osten Sacken (Gr. *first* + *to form*)

1859 *Protoplasa* O. S. Proc. Acad. Nat. Sci. Phila., p. 252.
1878 *Idioplasta* O. S. Cat. Dipt. N. Amer., p. 222.

The genus Protoplasa is confined to temperate North America. There are three known species, of which *P. vipio* O. S. and *P. vanduzeei* Alex. are western in their distribution, while *P. fitchii* O. S. is eastern. The general characters of the supposed larva are given above; the detailed account in connection with the species *P. fitchii* follows.

Protoplasa fitchii O. S.

1859 *Protoplasa fitchii* O. S. Proc. Acad. Nat. Sci. Phila., p. 252.

The remarkable insect *Protoplasa fitchii* is one of the rarest of the local crane-flies. There are scarcely a score of specimens extant in the various collections of the country, most of which are from the mountainous section of North Carolina. The fly has not been reared, but the writer has in his possession a larva that he refers with much confidence to this species. It is one of the most remarkable dipterous larvae that have ever come to the writer's notice, and, whether or not it belongs to Protoplasa, it should certainly be called to the attention of entomologists in the hope that it may some day be bred and its identity confirmed or ascertained. These peculiar dipterous larvae were discovered by H. S. Barber, C. T. Greene, and

R. C. Shannon, on the Potomac River near the mouth of Dead Run, Fairfax County, Virginia. They were found during the latter part of May, 1916, in a much-decayed maple log, where they were associated with the larvae of the syrphid fly, *Temnostoma bombylans* (Fabr.) (Barber, 1913). Greene attempted to rear the larvae procured at this time, but did not succeed. In May, 1917, he sent the writer one of the preserved larvae for study. Later Dr. Viereck was interested in the matter, and on May 27 he procured one fine, healthy larva, which was sent to the writer at Ithaca, New York. It arrived safely on the 29th, and was at once placed in rearing. Unfortunately this larva died the day after it came into the writer's possession, and this remarkable insect still remains unreared. Associated with this larva in the pieces of decaying maple in which it was shipped, were larvae of Temnostoma and a larva and a pupa of the tipulid *Epiphragma solatrix*.

The evidences that this larva is that of Protoplasa are numerous. It belongs, without doubt, to the Nematocera, and the immature stages of all the remaining families of that division have been made known. Many features in this larva point strongly to the condition in other families of crane-flies. The eucephalous condition of the head, and the elongate breathing tube, are suggestive of the Ptychopteridae; the five-lobed spiracular disk, the anal tracheal gills, the metapneustic respiratory system, and other features, are very similar to conditions in certain Tipulidae. However, there are conditions obtaining here that are found nowhere else in the Diptera, so far as is known to the writer, such as the combination of a eucephalous head of primitive organization, a stout, non-retractile breathing tube, the large, pinnately branched anal gills, the multisetose punctures on the head, and the details of structure of the mouth parts. The multisetose punctures are suggestive of the branched or plumose hairs of Ptychoptera, and give a possible hint of the origin and ancestry of this condition in the latter group. The writer cannot but regard it as suggestive that the larvae are found in direct association with those of Epiphragma in saturated decaying wood. He has mentioned in other papers (Alexander, 1910:254, and 1919d:883, 915) the remarkable superficial resemblance that exists between the adult flies of *Epiphragma fascipennis* and those of Protoplasa, both forms having very handsomely banded wings of a pattern not found in other species in the local fauna.

The only observations on the adult flies that the writer has ever been able to make were in reference to five specimens taken in New York State in 1909 (Alexander, 1910:254). These were swept from rich vegetation along the banks of the Sacandaga River in northeastern New York. The adult flies have never been recorded from the vicinity of Washington, but are regional, since the species ranges thruout the eastern United States as far south as Georgia (in the mountains).

Larva.—Total length, 11.8 mm.
Length excluding breathing tube, 5.6–6 mm.
Length of breathing tube alone, 5.8–6.2 mm.
Length of ninth segment of abdomen (chitinized part of breathing tube), 3.4–3.6 mm.
Length of anal gills, 2–2.1 mm.
Diameter of body, 2.3 mm.

Coloration pure white, head and apical two-thirds of breathing tube pale brown, chitinized. In the living larva there is a transparent, subcircular area on the dorsum of segment 7 thru which the beating of the heart can be clearly seen, but in preserved specimens this area is hard to perceive. (Plate XIII, 5)

Body eucephalous, entirely smooth, shiny, dorsum of segments 2 to 9 each with a transverse group of tiny points. Thorax with the first segment longer than the succeeding two segments taken together, narrowed anteriorly, broader behind; mesothoracic segment about half as long as the first and about twice as long as the very narrow metathorax. Abdominal segments gradually increasing in length to the seventh; segments 8 and 9 abruptly narrowed into a stout, elongate breathing tube which is about equal in length to remainder of body; basal, or proximal, part of tube (segment 8) shorter than terminal part (segment 9) and not chitinized; segment 9 elongate, chitinized, with a deep transverse constriction a short distance before tip; this apical part, and the region just before the constriction, smooth, the remainder of the last segment with numerous delicate transverse wrinkles. Spiracular disk (Plate XIII, 6) surrounded by five lobes, one dorsal, two lateral, and two ventral in position; dorsal lobe the smallest, lateral lobes the broadest; lobes tipped with sharp, chitinized spines, which are continued for a short distance down the outer face of each lobe; fringes of long hairs along margins of lobes; disk with a brownish tinge around spiracles and an elongate-oval median mark between, and slightly below, the spiracular level; inner face of ventral lobes with indistinct, tiny, brown punctures. Spiracles large, separated by a distance about equal to diameter of one. Anal tracheal gills two, one on either side of the base of segment 8, very large and pinnately branched, there being about fifteen branches to each gill; each of these branches constricted into four or five lobules; lobes at their tips broadly obtuse (Plate XIII, 9).

Head short and broad, epicranium chitinized. Across ventral face, the sclerite firmly united by a narrow transverse band; median part densely punctulate, this area delimited laterally and posteriorly by an indistinct curved line. On dorsum, the prefrons conspicuous and the clypeus distinct from the labrum. Head and mouth parts provided with numerous setiferous punctures, each of which is multisetose (from five to eight setae to each puncture). Chaetotaxy of epicranium (Plate XIII, 7) with three lateral groups of long bristles, the

posterior group being the longest and most dorsal in position; on ventral face, four punctures on either side (Plate XIII, 8); prefrontal sclerite apparently lacking setae, but on the epicranium proper, along margin of prefrons, a longitudinal group of six punctures on either side, the anterior pair the longest. Labrum semicircular in outline, outer margin fringed with long, stiff hairs; dorsal surface with two transverse punctures. Clypeus narrowly transverse, with four setiferous punctures in a transverse row. Dorsal median part of epicranium forming a subquadrate lobe whose lateral angles bear brushes of hairs; laterad of these angles a rounded hollow overlapped by a flat, bilobed operculum (this may be some modification of the antennae which should occupy about this position on the head). Mandible elongate, strongly chitinized, tridentate, the apical tooth the longest and more acute than the others, the middle tooth bluntly obtuse; inner posterior angle of mandible produced proximad beneath outer lobe of maxilla into a bluntly rounded lobe; mandible with a group of curved setae on scrobe near base, and a group of longer bristles lying distad and mesad of these setae on dorsal face of mandible. Maxilla with base, in a position of rest, concealed beneath head-chitin; palpus stout, antenniform, two-segmented, the basal segment short and stout, the apical segment much shorter and narrower, with a small, lateral, sensory papilla; outer lobe of maxilla produced cephalad as a stout, digitiform lobe which is densely hairy.

FAMILY Ptychopteridae

Larva.— Body eucephalous, metapneustic, long and slender, the caudal end prolonged into a more or less completely retractile breathing tube bearing the spiracles at the tip. Lobes surrounding spiracular disk indistinct. Anal gills two, elongate-cylindrical, unbranched. Integument with tiny hairs (Ptychoptera), or with slight warty protuberances (Bittacomorpha), or with conspicuous elongate tubercles (Bittacomorphella). Pseudopods on abdominal segments 1 to 3 each bearing a curved claw. Head complete; eyespots distinct. Mandibles opposed. Mentum many-toothed (Ptychopterinae) or merely bilobed (Bittacomorphinae).

Pupa.— Usually with one of the two pronotal breathing horns greatly elongated, much longer than the body (this may not be true in Bittacomorphella); in Ptychoptera and Bittacomorpha it is the right horn that is elongated, the left being degenerated; in Bittacomorphella the right horn is degenerated. Tarsal sheaths all parallel in the Ptychopterinae, the fore pair overlying the middle pair in the Bittacomorphinae. Abdomen covered with setiferous tubercles arranged in transverse rows on tergites and sternites, and more or less in longitudinal rows on pleurites. Cauda with a powerful dorsal median lobe near base of segment 8.

The family Ptychopteridae includes three genera falling in two tribes: the Ptychopterinae including the single genus Ptychoptera, and the Bittacomorphinae including the "phantom crane-flies," Bittacomorpha and Bittacomorphella. The habits of these species are discussed below in connection with the various genera. The following keys separate the subfamilies of the Ptychopteridae:

Larvae

Mentum with outer margin finely serrated; mandibles with three large outer teeth; pseudopods small; coloration yellow or brown. . . . . **Ptychopterinae** (p. 773)
Mentum bilobed, not toothed; mandibles with a single large outer tooth; pseudopods prominent, each with a conspicuous curved claw; coloration rusty red or black.
Bittacomorphinae (p. 779)

Pupae

All tarsi lying parallel; wing pads with *M* branched. . . . . **Ptychopterinae** (p. 773)
Fore tarsi lying above middle tarsi; wing pads with *M* unbranched.
Bittacomorphinae (p. 779)

The immature stages of this group of flies have long been known, having been investigated by Réaumur (1740), Lyonet (1832), and other early workers. The immature stages of the common American species *Ptychoptera rufocincta* are herein recorded for the first time. The unknown Ptychoptera described by Malloch (1915–17b:240–241) is evidently *P. lenis* O. S. and is here considered as that species.

The most important literature on the Ptychopteridae is as follows:

Ptychoptera paludosa	Larva, pupa, general.	Réaumur, 1740, pl. 6.
Ptychoptera paludosa	General	Wesenberg-Lund, 1915:348–351.
Ptychoptera lacustris	Larva	Beling, 1886:171–172.
Ptychoptera contaminata	Larva, general	Van Gehuchten, 1890. (Histology of the alimentary canal.)
Ptychoptera albimana	General	Cameron, 1917:65.
Ptychoptera albimana	Larva, pupa, general.	Topsent, 1914–16.
Ptychoptera sp. (*lenis* supp.)	Larva	Malloch, 1915–17b:240–241.
Ptychoptera sp	General	Léger and Duboscq, 1909. (Protozoan parasites.)
Ptychoptera sp	Larva, general	Grobben, 1876. (Morphology.)
Ptychoptera sp	Larva, general	De Meijere, 1916:188–191, figs. 14–20. (External morphology.)
Ptychoptera sp	General	Lyonet, 1832.
Bittacomorpha clavipes	Larva, pupa, general.	Hart, 1898 [1895]:189–195.
Bittacomorpha clavipes	General	Needham and Betten, 1901:574.
Bittacomorpha clavipes	General	Howard, 1912:95–96.
Bittacomorpha clavipes	Larva, pupa	Malloch, 1915–17b:239–240.
Bittacomorpha clavipes	General	Weston and Turner, 1917:53.

Van der Wulp (1857), Miall (1895), Grünberg (1910), and Brunetti (1912) also give general accounts of the immature stages of Ptychoptera, for the most part taken from the earlier works cited above.

SUBFAMILY **Ptychopterinae**

Genus **Ptychoptera** Meigen (Gr. *fold* + *wing*)

1800 *Liriope* Meig. Nouv. Class. Mouch., p. 14 (*nomen nudum*).
1803 *Ptychoptera* Meig. Illiger's Mag., vol. 2, p. 262.
1856 *Ctenoceria* Rond. Dipt. Ital. Prodr., vol. 1, p. 187.

Larva.— Head oval to subpyriform, broadest behind, narrowed in front, not heavily patterned above; setae of head branched or plumose. Submentum large, usually but a little narrowed posteriorly, the anterior lateral angles slightly produced; mentum broader than long, outer margin with numerous teeth (18–22). Prementum with palpi rather small, lying parallel, densely hairy on outer, or ventral, face. Mandible with three powerful outer teeth and about six smaller inner teeth. Maxilla with the cardines elongate-triangular, with three setiferous punctures; maxillary palpi antenniform, cylindrical. Labrum broad, transverse, with dense tufts of hair beneath. Integument almost smooth, without prominent warty elevations. Pseudopods low, with small claws.

Pupa.— Head small, with a reduced cephalic crest. Sheaths of maxillary palpi elongate, the tips projecting around knee joints of fore legs. Leg sheaths with all the tarsi parallel, not overlapping one another. Wing sheaths with media branched. Pronotal breathing horns very unequal, one (usually the right) exceedingly elongate, longer than remainder of body, the other tiny, degenerate. Abdomen set with transverse and longitudinal rows of small setiferous tubercles on the segments.

Ptychoptera is a small genus including sixteen described species, almost all occurring in the Holarctic region, with a few species in India and Formosa. Two species are found in tropical Africa, and another, an undescribed form, in southern South America; hence the genus is probably found thruout the world in countries in the temperate zones, with the probable exception of Australia.

The literature on the immature stages of this genus is summarized under the family account.

Topsent (1914–16) has furnished the best account of any species of the genus Ptychoptera. His observations refer to *Ptychoptera albimana*. The following notes are extracted from Topsent's paper:

The eggs range in number from 520 to 587, averaging 554. They are pale yellow, slightly arcuated, the surface curiously ornamented, the dimensions being 0.825 by 0.264 millimeters. The duration of the egg stage is seven days. The newly hatched larva measures 3.85 millimeters, the respiratory tube 0.99 millimeters. The adult larva measures 77 millimeters, of which the respiratory tube is 20 millimeters. The growth of the larva is rapid. When fifteen days old it measures, when extended, 25 millimeters. When sixty-seven days old it measures 45 millimeters. The pupal stage is from ten to twelve days, averaging eleven days. There are normally two generations a year.

De Meijere (1916:188–191) gives a critical account of the structure of the larva of a European Ptychoptera. It agrees well with the description of *P. rufocincta* given below, the most conspicuous differences shown by De Meijere's species being as follows: labium with the submentum having the sides straighter; mentum with the anterior margin evenly, but gently convex, with only eighteen evident teeth. The details of the maxilla

especially of the setae on the cardines, are not the same. However, the generic characters given above include all the species to which the writer has been able to refer.

Malloch (1915–17 b: 240–241) describes and figures an American Ptychoptera which is presumably *P. lenis* O. S. It agrees closely with the other forms in most respects. The author indicates the mentum as having three distinct parts, the median part being projected beyond the level of the lateral parts and having more teeth (eight instead of six). Malloch's specimens were taken in the Yellowstone Park, Wyoming, in August, 1890. From the locality data it is almost certain that the larvae belong to the common *Ptychoptera lenis* of the western United States.

Tonnoir (1919) describes a curious sexual dimorphism in the genus Ptychoptera.

Ptychoptera rufocincta O. S.

1859 *Ptychoptera rufocincta* O. S. Proc. Acad. Nat. Sci. Phila., p. 252.

The species *Ptychoptera rufocincta* is common around wet swales and among open shrubbery. The adult flies are on the wing from May to early July, and again in late August and early September; they may be double-brooded. In appearance they are conspicuously unlike their relatives of the Bittacomorphinae, rather resembling certain large fungus gnats (Mycetophilidae).

The larvae live in situations similar to those frequented by Bittacomorpha, and often occur in the same associations — with larvae of *Limnophila* (*Lasiomastix*) *macrocera*, *Pilaria tenuipes*, *P. recondita*, and *Orioptera chlorophylla*, as well as with many Chironomidae, leeches, nematode worms, and mollusks. In appearance they are strikingly different from the larvae of Bittacomorpha, being pale, white or yellowish white, with the body almost smooth, not covered with the dense transverse rows of setiferous tubercles found in Bittacomorpha, and with the pseudopods on the basal abdominal segments poorly developed. The larvae of this species are smaller than those of Bittacomorpha, with the head proportionately much smaller. In structural details, however, they are rather similar to the larvae of Bittacomorpha. The larvae of *Ptychoptera rufocincta* feed on the decaying vegetable matter in their haunts. When fully grown, the pupa forms within the last larval skin, and the elongate pupal spiracle is coiled about the mesothorax, as described

for *Bittacomorpha clavipes* (Hart, 1898 [1895]: 191). Careful breedings o this species in 1913 at Orono, Maine, placed the indoor pupal life at fou days and eighteen hours, and that in nature at probably five days — a unusually short pupal duration.

Larva.— Length, when fully grown, 30–32 mm.; when fully extended, about 35 mm. Diameter, 2–2.2 mm.

Head light reddish brown, not marked with darker spots as in Bittacomorpha; bod whitish or pale yellow; tomentum short, pale; seventh and eighth segments of abdome and breathing tube, light brown.

Body almost smooth, sparsely clothed with short, appressed hairs arranged in indistin transverse rows, on intermediate segments of body there being about twenty of these row body not at all tuberculate, as in Bittacomorpha. Prothoracic segment short, not so lon as mesothorax; metathorax nearly as long as preceding two segments combined. (In old larvae that are about to pupate, the right pupal breathing horn may be seen coiled unde neath the skin of the mesothorax.) First five abdominal segments swollen posteriorly int a ring that completely surrounds the segments; first three abdominal segments with lov indistinct pseudopods on either side of the median line, each with a small, recurved clav pseudopods after first pair more widely separated than, and not so well developed as, the Bittacomorphinae. Abdominal segments 4 and 5 more elongate, swollen posterior but not bearing pseudopods; segment 6 narrowed behind, with a few scattered, outspreadi hairs; segment 7 narrower than preceding and telescopic within itself, at about two-fift the length there being a transverse row of long hairs marking the limit of telescoping; whe fully extended, segment 7 a little longer than segment 8; segment 8 a little narrower, an telescopic basally into segment 7. (The parts of segments 7 and 8 which are exposed the retracted condition are brown and subchitinized, and bear scattered, outspread hai which are most numerous near the caudal end of the exposed part and here form transver rows; similar rows of sparse, setiferous punctures are on the dorsum of the swellings on th first five abdominal segments.) Breathing tube (segment 9) retractile into segment 8 f about one-fourth its length; when retracted, completely concealing gills. Tracheal gi two, elongate-cylindrical, situated near base of segment 9; in normal position of rest, gil usually projecting about one-half their length beyond end of segment 8. Apex of breathin tube truncated but without well-defined lobes.

Head small, proportionately much smaller than in Bittacomorpha; oval to somewh pear-shaped; narrow anteriorly, broadened behind, near posterior margin abruptly narrowe Prefrons broad, conspicuous. (As noted by most earlier writers on the genus Ptychoptera, th head bears numerous punctures with setae which are plumose or have a branched appearan [Plate XV, 20]. The writer has examined numerous specimens under high magnificati and is inclined to believe rather that in some cases several bristles arise from a single punctu and are closely approximated basally, altho free distally, and that the plumose appearan is here merely apparent. In other cases, however, actual basal fusion has taken place. Th number of free tips from a puncture varies from three to six, five and six being comm numbers.) Labrum broad, transverse, on disk two large setiferous punctures beari branched setae; on either side beneath, conspicuous tufts of long hairs, these tufts continu

bliquely proximad to near median line, where there is a median lobe densely covered with ng hairs. Epipharynx small, subquadrate, margin almost transverse, with about seven lunt teeth; sides of organ with long hairs which are directed backward. Labium (Plate IV, 12) with submentum much narrowed on basal half, sides subparallel, thence expanded that cephalic end is about twice as wide as caudal end; anterior lateral margins produced to blunt projections; mentum (Plate XV, 17) broadly subquadrate, anterior margin nearly ransverse and with from twenty to twenty-two teeth forming an irregular comb. (There is onsiderable variation in the shape of this comb and in the form of the individual teeth comrising it; usually the median third of the mentum is produced outward beyond the lateral arts, but this condition is not always well-marked; the individual teeth may be blunt or cute. In the specimen shown the normal condition is illustrated; the central lobe includes x teeth, and each lateral part about seven teeth, the lateral teeth being usually a little the rger; in some specimens the median lobe has the teeth very indistinct, while in others ere is a conspicuous tendency for the median pair to unite into a single broad tooth.) rementum pale basally, indistinctly covered with pale papillae; palpi lying close together, bparallel, the lateral parts with short, dense hairs, the ventral face with shorter papillae; ch lobe bearing at tip a small, blunt, cylindrical knob which is slightly chitinized. Antenna late XV, 18) short, almost cylindrical but slightly narrowed basally, bearing on truncate ex about five sensory papillae of various diameters, one being much the largest, two others ng long and very slender; one of the papillae is bisegmented, the apical part being more nder than the basal part. (De Meijere [1916, fig. 14] shows his European Ptychoptera having the antennae two-segmented and with the sensory papillae very different from condition found in *P. rufocincta*.) Mandible (Plate XV, 19) strong and powerful; cutting ge subtriangular, with three large outer teeth and about six or seven small inner ones; the larger teeth the outermost is the slenderest, the third is the largest and stoutest; small er teeth subequal in length, the outermost stout, inwardly the teeth becoming more nder; mandible on ventral face near margin with two powerful setae, the posterior one en recurved, the anterior one directed forward. Maxilla (Plate XV, 19) with cardines ghly elongate-triangular, proximal angle acute, ventral face with three large setiferous ctures bearing several bristles of unequal length (the writer has not been able to locate e on the middle puncture); outer edge of sclerite with a fringe of long hairs, longest at row inner end of segment; stipites roughly triangular, with a group of short spines at x; palpi antenniform, stout, cylindrical, with sensory papillae at tip (one large papilla, ut three of medium size, and three or four small ones); outer lobe of maxilla with a small, -shaped or subcylindrical, knob at its outer angle, below which the rounded lobe is sely clothed with long, pale hairs; caudad of these, along margin, a row of from six to nt powerful spines and a few long hairs.

Pupa.— Total length, 34.3–40 mm.
Length excluding breathing tube, 14.5–15.8 mm.
Length of breathing tube alone, 19.8–26 mm.
Width of body, d.-s., 1.6–1.7 mm.
Depth, d.-v., 1.7–1.8 mm.

Pronotal breathing horns reddish brown, dark brown at extreme base; thorax, wing aths, and leg sheaths dark brown; abdomen whitish, with small tubercles and broad

chitinized apices to segments dark brown. Pupa most readily distinguished from pu of Bittacomorpha by the venation, the position of the tarsal sheaths, and the short, no stellate abdominal tubercles. (Plate XIV, 13.)

Anterior cephalic crest small, deeply bilobed by a broad V-shaped notch, the round lobules roughened and each terminated by a single long hair. Dorsad of these, two smal and slenderer, very widely separated, tubercles, each lying just inside antennal sheat Antennal bases located on ventral side of head, between eyes; antennae bent dorsad a thence caudad around knee joints of fore legs, the tips lying just outside middle tibiae; api antennal segments showing distinctly thru sheaths. Sheaths of maxillary palpi elonga tips curved over knee joints of fore legs. Clypeus smaller and narrower than the conspicuo labium, transversely wrinkled. Labium rectangular, each half with tips obliquely truncat (Plate XIV, 14.)

Pronotum with lateral ventral angles almost square, each with about two small set Breathing horns very unequal in length; the right one greatly elongated, much longer th remainder of body, enlarged at extreme base, the outer part with numerous papillae wh are more numerous and more approximated toward end of organ, these papillae lying in single straight line which makes a long spiral around organ; left breathing horn very sm and degenerate, only a little longer than sheath of maxillary palpi, curved, with about dozen papillae which are closely crowded toward apex of organ. Mesonotum finely a transversely wrinkled, prescutum with a very acute V-shaped dorso-median mark, its ap directed backward; scutal lobes projecting, each with a few tiny hairs. Postnotum w two small tubercles at about two-thirds its length, one on either side of a pale median li Metanotum short, sheath of halteres extending just beyond base of second abdomi segment. Wing sheaths clearly showing venation, the branched media being characteris of the genus; wing sheaths extending almost to end of second abdominal segment. I sheaths with tips of fore and middle tibiae enlarged, and with inner apical angle of e produced into long points for the long tibial spurs of adult flies. Leg sheaths extending just before end of third abdominal segment; all six legs lying side by side, not overlapp as in Bittacomorpha (Plate XV, 21).

First abdominal segment chitinized above, apical half with a few weak tubercles. Dors of segments 2 to 6 with posterior margins each having a chitinized band set with ab twenty-five to thirty setiferous tubercles, the outermost ones being the largest; remain of dorsum of each segment with irregular transverse rows of scattered tubercles, on narr interrupted, chitinized bands; usually one of the bands, at about midlength of segme broader and more strongly chitinized than the others; these bands obliterated on poste segments, but caudal band here very wide; about fifteen of these rows on segments 2 6, and from twenty to twenty-five rows on segments 3 to 5; these bands not regularly tr verse, but anastomosing rather freely, not occupying more than half of abdominal surf segment 7 with the broad caudal band only; tubercles rather short, with three or four sh irregular spines at tip, these not presenting a stellate appearance as in Bittacomorp Abdominal sternites similar to dorsum, tubercles lacking where leg sheaths rest aga segments 2 and 3; segments 4 to 6 with transverse rows similar to those of dorsum weaker; caudal bands on segments 4 to 7 very broad, the caudal margin with tuber there being about twenty tubercles on segment 4, the number gradually decreasing to

ıent 7, on which there are about fifteen. Abdominal pleurites with tubercles arranged in ɔngitudinal rows, there being about six rows on each of segments 2 to 6, the rows being lmost continuous for the whole length of abdomen; tubercles at caudal margin of each egment enlarged and powerful; on segment 6 the rows converging behind into a single owerful tubercle on caudal margin of segment; a similar enlarged tubercle on caudal margin f seventh segment; segment 7 and cauda narrowed. Male cauda (Plate XV, 22) with a rominent dorso-median lobe projecting directly away from the body; dorsal sheaths short, ndistinctly bilobed; ventral sheaths very elongate, divergent (Plate XV, 23). Female cauda Plate XV, 24) with the same prominent dorso-median lobe; acidotheca of ovipositor long, traight, beyond its midlength a blunt, conical tubercle directed laterad and slightly caudad; ternum (Plate XIV, 15) with ventral lobe only about half length of tergal acidothecae, caudal argin with three lobules.

Nepionotype.— Orono, Maine, June 24, 1913.
Neanotype.— With the larval type.
Paratypes.— Both larvae and pupae, June 24 to July 5, 1913.

SUBFAMILY Bittacomorphinae

The following keys separate the genera of the subfamily Bittacomorhinae:

Larvae

ze small (total length under 20 mm.); coloration black, breathing tube light yellow; breathing tube entirely retractile; body covered with very long projections which are incased in a black, horny substance; mandibles with an inner comb of teeth.
Bittacomorphella Alex. (p. 779)

e larger (total length over 40 mm.); coloration rusty red; body tapering gradually to the ong, slender, partly retractile, breathing tube; body covered with transverse rows of shorter, tellate tubercles; mandibles without an inner comb of teeth.
Bittacomorpha Westw. (p. 783)

Pupae

e small (length, excluding breathing horn, under 12 mm.); right breathing horn small, legenerate; abdominal tubercles weak, tipped with several strong setae.
Bittacomorphella Alex. (p. 779)

e larger (length, excluding breathing horn, over 14 mm.); right breathing horn elongate, iliform, longer than the body; abdominal tubercles strong, elongate, crowned by a circlet f four or five spines and tipped with a setiferous papilla...*Bittacomorpha* Westw. (p. 783)

nus Bittacomorphella Alexander (Gr. diminutive of *Bittacomorpha*)

1916 *Bittacomorphella* Alex. Proc. Acad. Nat. Sci. Phila., p. 545.

arva.— Body short, covered with very prominent projections which are longest on lateral caudal parts of body. Pseudopods prominent, with very large, curved claws. Breathing e short, entirely retractile within body. Head subquadrate, the foramen ventral in sition; setae of head unbranched. Mandible with an inner comb of teeth. Mentum bed, cephalic margin untoothed. Coloration black; breathing tube light yellow.

Pupa.— Right breathing horn very short, degenerate. Fore tarsi overlying middle tarsi. bercles on abdomen moderately elongated, not crowned by a circlet of spines as in Bittanorpha, but tipped with a long seta.

The genus Bittacomorphella contains but two described species, th genotype, *B. jonesi* (Johns.), and the larger *B. sackenii* (Röder) fron western America, the immature stages of which are wholly unknown There is no published literature on the biology of this group of crane-flies

Bittacomorphella jonesi (Johns.)

1905 *Bittacomorpha jonesi* Johns. Psyche, vol. 12, p. 75–76.

Bittacomorphella jonesi is a curious little phantom crane-fly, not uncom mon in cold Canadian woods thruout the Northern States, where it i usually found near running water or springs and often in small, dar ravines or along shaded runs. The adult flies sometimes lurk beneat low, dark bridges and culverts, where they are often associated wit species of Dolichopeza and Oropeza. An account of the habits of th adults of this species may be found in an earlier paper by the writ (Alexander, 1916b:545–546).

The larval habitat is very different from that of other local speci of the family, which, as a rule, prefer open swamps, swales, or w meadows. The larvae of this species live in rich organic mud in shad woods. They were first found on the Bool hillside at Ithaca, New Yor beneath decaying beech leaves in wet or damp mud which was mixe with old beechnuts, hulls, acorns, butternuts, broken decayed twig and similar débris. The Bool area is a very steep hillside with a gener northern exposure, heavily shaded with tall forest trees. In former da it extended far to the eastward and was connected with Slim Jim Wood near the second bridge in Forest Home. The cut area is now a pastu but patches of skunk cabbage and cat-tails still persist. On the shad hillside the skunk cabbage occupies pockets or level areas where the s is largely calcareous. The forest cover consists of beech, hard mapl basswood, yellow birch, red oak, butternut, elm, a few large alders, few aspens, and on the surrounding hillside a thick stand of hemloc The shrubs include *Ribes floridum* L'Her., *Cornus alternifolia* Linn. f., a similar species. The herbage at this season is of the dominant skun cabbage, young seedlings of *Impatiens biflora* Walt., *Geum rivale* Lin and *Cardamine Douglassii* (Torr.) Britt. In places there are thick ma of mosses, *Brachythecium rutabulum* (Linn.) B. & S., on the limy soil, a Amblystegium on decaying prostrate limbs.

The curious larvae of Bittacomorphella were here found associated ith the following crane-fly larvae and pupae: *Dicranomyia stulta*, *imnophila adusta*, *L.* (*Dicranophragma*) *fuscovaria*, *Ulomorpha pilosella*, enthoptera, *Molophilus hirtipennis*, *Erioptera megophthalma*, *Ormosia nocens*, *O. nigripila*, *Tipula collaris*, *T. oropezoides*, *T. cayuga*, and thers. In addition numerous other natural associates were found, such s the larvae of a carabid beetle, *Nebria sahlbergi* Fisch., sow bugs, mollusks, nd a great variety of other organisms. On July 10, 1914, adults of ittacomorphella were not uncommon in the same association, at which me they were flying with other crane-flies such as *Dicranoptycha germana*, *Iolophilus hirtipennis*, *M. pubipennis*, *Erioptera vespertina*, *E. venusta*, nd *Gonomyia blanda*.

The first larvae of Bittacomorphella were found on May 11, and at at time were almost fully grown. They present a very remarkable ppearance, being black or very dark in color and covered with numerous ng projections. The breathing tube, which is capable of entire retraction thin the body, is very short, and is light yellow, in contrast with the mainder of the body. The larvae are, as a rule, very slow and sluggish their movements, but when disturbed they become more active. Large d small larvae, of two distinct sizes only, were often found in the same uations at the same time. A fully grown larva was placed in rearing June 11, 1917, and emerged as an adult male on June 24. This pro- les for a pupal duration of not more than thirteen days, but the pupal ge is undoubtedly much shorter.

arva.— Total length, 15–17 mm.
Length exclusive of breathing tube, 12.5–14 mm.
Length of breathing tube, 2.4–3 mm.; to base of gills, 1.3–1.8 mm.; beyond gills, 1.1–1.2 mm.
Greatest diameter across body, 1.7–2 mm.

oloration dark brown to almost black, breathing tube light yellowish; in young indi- iials and occasional older specimens, coloration more rusty.

ody short, stout, cylindrical but appearing depressed, covered with numerous elongate ections.. Breathing tube very short and capable of complete retraction within body te XVI, 25). Body appearing proportionately broader, and tapering more abruptly to thing tube, than in other species of the family herein discussed, this appearance being to great length of lateral body projections.

he most notable single feature of larva consisting of the numerous projections from y (Plate XVII, 33), these being incased in a blackened, horny substance which is some- it brittle. Usual shape of body extensions cylindrical, slender, and generally simple

except for those near end of body, which are asymmetrically once-forked. Basal half of pr jections heavily chitinized, but distal end almost transparent. Entire surface of projectio beset with numerous transverse rows of short hairs, usually about nine to twelve hairs in ea row, nine and ten being common, these hairs doubtless serving to hold the blackened, horn covering of the projection. Sensory papillae (Plate XVII, 34) borne at or near apices of pr jections, each with a long bristle; these papillae narrowed at base, thence enlarged to for a head, on which bristle is inserted; usually one or two bristles to each projection, b occasionally an additional one present, which is much smaller and degenerate. Dors body projections occupying transverse rows across segments, those near lateral and caud parts of body being long and powerful, those on median region being short and degenerat segments of thorax and abdomen subdivided into false segments, these transverse ro occupying caudal margins of these segments, there being usually from four to six of t weak projections between the powerful lateral ones. In addition to these projections, spar branched hairs lying in the same transverse rows (Plate XVII, 35). Projections at end body surrounding base of breathing tube all long and powerful, and, as stated above, so weakly bifurcate. Ventral body projections similar to those of dorsum but relatively smalle

Abdominal pseudopods feebly chitinized at tips, with very large, slightly curved cla which are but little shorter than the pseudopods themselves (Plate XVII, 32). Breathi tube short and stout, surface before apex transversely wrinkled. Papillae rather numero bearing sense hairs scattered over surface of tube, those just back of apex short and spi like, those farther back long and slender, very like and homologous to the bristles terminat the body projections, as discussed above. Gills two, stout, about one-third length of termi section of breathing tube. Body projections incrusted with a black, horny substance, discussed above; on lateral projections, apical setae likewise incased, at least basally, pr ducing a bilobed or even a trilobed appearance; this black corneous incrustation brittle a easily removed, leaving projection and bristles intact.

Head subquadrate, sides nearly parallel, occipital foramen ventral in position (Plate XV 26); surface of head covered with numerous small, chitinized points which are longes posterior angles; anterior ventral angle slightly produced; two setiferous punctures ventral surface, one on either side just behind anterior angles, the other closer to foram Dorsum with setae arranged as shown in Plate XVI, 27; setae simple. Labrum (Plate XV 31) with four dorsal setiferous punctures along anterior margin, the median pair clos approximated; another powerful seta occupying each lateral angle on dorsal side; de brushes of long hairs on either side beneath. Epipharynx (Plate XVII, 31) supported by t powerful chitinized arms connecting across midventral region and then extending later and expanding outwardly to form posterior margin of labrum; surface of epipharynx w closely appressed teeth. Labium (Plate XVI, 28) with cephalic margin of mentum alm entire, the broad median part produced cephalad and feebly bilobed; palpi with a de fringe of long hairs around base and with sensory papillae at tips. Antenna (Plate X 30) short, cylindrical, somewhat globular or barrel-shaped; about four elongate papi and two or three shorter ones, these papillae terminal in position, the largest one occu ing the inner side. Mandible (Plate XVI, 29, 30) with the outer angle a powerful h bearing smaller teeth on ventral face at about midlength; inner angle flattened, and, besi terminal blade, bearing a comb of about five teeth, the innermost being the longest

derest; a dorsal line of strong setae extending from base of outer hook inward; outer e of mandible with two strong setae, these protected at their bases by small dorsal ears, projections, from the mandible; dorsal face of mandible with a powerful hinged prostheca; r base of mandible on dorsal face a curious five-lobed sensory organ. Maxilla (Plate I, 29) with the cardo triangular, the ventral or outer face with two closely approximated ferous punctures; stipes triangular, with three strong setae near palpus; palpus enniform, cylindrical, rather elongated, and with about six sensory papillae at tip, being much longer than the others; outer lobe of maxilla with cephalic margin blackened chitinized, inner angle with a dense brush of long hairs.

Pupa.— Length excluding breathing horn, 9.5 mm.
Width, d.-s., 1.7 mm.
Depth, d.-v., 1.4 mm.

The following description is taken from the cast pupal skin of the only cimen that was reared:

ntennal bases approximated on front between eyes. Clypeus bluntly rounded at apex, sversely wrinkled. Lobes of labium (Plate XVII, 36) broad, rounded apically; maxillary i short and stout, broad at base, gradually narrowed to the short tip, which is not rved. (The structure of the head and the eyes indicates some peculiar characters not essed by the pupae of related genera, but the cast pupal skin is insufficient for accurate nosis.) Two bristles below eye and just above base of palpus, and a longer and more ier seta farther laterad. Sides of head behind antennae appear to be produced laterad blunt points. Right breathing horn small, degenerate, much curved. (In the single l skin available, it cannot be determined whether the left horn has been broken off or is veloped.) Just laterad of each breathing horn a small tubercle bearing a long seta. al lobes with about four stout setae. Tarsal sheaths of fore legs, as in the subfamily, ying the middle pair but shorter (Plate XVII, 37).

domen with chitinized bands extensive, as in Bittacomorpha. Arrangement of tubercles as in other species of family. Tubercles shorter and weaker than in Bittacomorpha ot crowned by a circlet of spines, each being tipped with one or more (four or five) long (Plate XVII, 38); the pleural tubercles the longer and many of them multisetose. a of male, in general features, similar to that in Bittacomorpha, the dorsal median (Plate XVII, 39) stout, the ventral horns (Plate XVII, 40) short and powerful, ed laterad; horns on dorsal lobes apparently lacking.

pionotype.— Ithaca, New York, May 30, 1917.
anotype.— Cast pupal skin, reared June 23, 1917.
ratypes.— Topotypic, May 15 to June 10, 1917.

us Bittacomorpha Westwood (Gr. *Bittacus* + *shape*)

835 *Bittacomorpha* Westwood. London and Edinburgh Phil. Mag., vol. 6, p. 281.

va.— Form elongate, body gradually narrowed behind into the partly retractile hing tube. Integument with transverse rows of tubercles. Pseudopods on abdominal nts 1 to 3 prominent, with large curved claws. Head subpyriform, dorsum with rows

of prominent black spots converging behind. Mandible stout, with a single powerful o tooth. Mentum bilobed, anterior margin not comblike. Color of body, rusty red.

Pupa.— Right pronotal breathing horn very elongate; the left very small and sh subdegenerate. Fore tarsi overlying middle tarsi. Tubercles on abdomen very long, loc on broad transverse bands of chitin, each tubercle with a star of four or five spines surrou the apex, which bears a long seta.

The genus Bittacomorpha, as here restricted, includes but two species the genotype, *B. clavipes* (Fabr.), and *B. occidentalis* Ald. of west America, concerning the biology of which nothing has been record The literature on the immature stages of *Bittacomorpha clavipes* is su marized under the family account (page 773).

Bittacomorpha clavipes (Fabr.)

1781 *Tipula clavipes* Fabr. Spec. Ins., vol. 2, p. 404.
1835 *Bittacomorpha clavipes* Westw. London and Edinburgh Phil. Mag., vol. 6, p.

Bittacomorpha clavipes, the "phantom crane-fly," is a common widely distributed species thruout North America east of the Rock It is easily recognized by the black-and-white-banded legs, with t conspicuously enlarged and swollen metatarsi. The species is v characteristic of alder swamps and the wet margins of ponds. Whil copulation the insects often fly, the female ahead, the male trailing behind like the tail of a kite. When they alight on a plant stem, female is invariably uppermost, the male often hanging free with n of its feet on a support. The swollen metatarsi are almost comple filled by the tracheae, and these serve to buoy the insects as they about in the wind. Brues (1900) describes these peculiar tracheal dilat in detail. He says, in part:

When flying, Bittacomorpha uses the wings scarcely at all, relying in great measure wind currents for transportation. The legs are exceedingly light, as the exoskeleton is and delicate, and encloses practically no tissue which can serve to increase their w

In a letter from Dr. J. G. Needham, dated September 27, 1917, valu data on this habit of drifting are furnished, as follows:

Yesterday while crossing the Fall Creek bridge near my home on Cornell Heights, I ma observation on Bittacomorpha that interested me greatly. A breeze was blowing up the g and on the breeze a Bittacomorpha was drifting rapidly upward in the usual flight att with broadly outspread legs, the swollen metatarsi hanging vertically, all phantom-l slenderness and in strongly contrasting black and white. It came up from below the of the rail, swept past within two feet of my face, and passed on upward with the breeze lost to view, perhaps 100 feet higher than the bridge, and much farther upstream.

e creature can fly only very slowly and here was moving several times faster (I could not e whether it was using its wings), it was obviously drifting in the wind. Perhaps this is a rmal function of the expanded metatarsi.

The larvae are usually abundant in decaying vegetable matter in rich rganic mud about ponds and in swamps. The writer has found them pecially numerous in the Basin Swamp at Orono, Maine (in 1913), nd near Round Pond at McLean, New York. At Orono they were ssociated with larvae and pupae of *Ptychoptera rufocincta, Limnophila acrocera, Pilaria tenuipes, P. recondita, Erioptera chlorophylla,* a variety f chironomid larvae, numerous larvae of Trichoptera in their cases, ematodes, and leeches. Needham and Betten (1901:574–575) give a ummary of the larval habitat of this species as they found it in the orthern Adirondacks. Weston and Turner (1917:53) have recorded ie larvae as being scavengers and thus serving as important factors the elimination of sewage in the Coweeset Stream near Brockton, assachusetts.

The immature stages of this interesting crane-fly have been well con-lered by Hart (1898 [1895]:189–195), whose account has been briefly mmarized by Howard (1912:95–96). The larvae are found in shallow ter that is filled with decaying vegetable matter. Here they live in mat of dead stems of rushes, grasses, and willow leaves, in semi-gnant or slowly flowing water. The larvae are elongate-cylindrical, th a long, partly retractile breathing tube. They are deep rusty red brown in color, quite distinct from the pale whitish larvae of Ptychoptera the black larvae of Bittacomorphella. They feed on decaying vegetable tter, diatoms, and mud that is filled with organic matter. They rest neath the surface of the water, with the tip of the extended breathing be at the surface film or just beneath the surface, in the latter case athing by means of the small tracheal gills. When about to pupate, e very long, coiled breathing tube of the pupa is wound around the orax beneath the larval skin. On pupation the tube soon straightens into a very long, stiff, bristle-like structure. Like the larvae, the pae rest beneath the surface of the water, with the tip of the breathing be projecting above the surface film. The pupal duration is apparently out a week.

Larva.— Length when fully extended, about 60 mm.
Length of breathing tube, about 20 mm.
Diameter of body, about 2.6 to 3 mm.

Body tapering gradually at either end, posterior end prolonged into breathing tub
Usual color pale rusty brown, but the writer has found a few nearly full-grown specimer
which were as pale in color as the larvae of Ptychoptera. Body covered with numerou
transverse rows of small tubercles, or papillae, which bear short setae. Head broadly ovate
convex above, where it is conspicuously marked with rows of black spots, these interrupte
lines converging behind. Mouth parts in general similar to those in Bittacomorphella, th
main points of difference being as follows: mandible (Plate XVIII, 42) shorter and stoute
ending in a powerful outer tooth, the comb of inner teeth being reduced to about eight sma
tubercles, the two bristles on outer margin of mandible not overlapped by projecting "ears"
labium (Plate XVIII, 41) shorter and stouter, with a different arrangement of papillae; epipha
ynx long, narrowed behind, distinctly bilobed, each half with parallel rows of long, comblik
teeth projecting proximad; anterior comb of epipharynx with the anterior teeth the large
the teeth gradually reduced in size behind; posterior comb with the rows of teeth widel
separated anteriorly, approximated behind so as to be contiguous or nearly so at their end
space between these rows filled with long hairs; anterior teeth small and feebly chitinized
posterior teeth stronger. First three abdominal segments bearing conspicuous pseudopod
each terminated by a sharp, slender claw which fits into a groove on the face of the pseudopo

Pupa.— Total length, 40–60 mm.
Length excluding breathing tube, 15.5–25 mm.
Length of breathing tube, 25–35 mm.
Degenerate breathing tube, length 2 mm., diameter 0.2 mm.
Width, d.-s., 1.8 mm.
Depth, d.-v., 2.6 mm.

Breathing tube light brown; wing sheaths brown; leg sheaths light brownish yellow an
dark brownish black, alternated, corresponding to the leg markings of the adult fly. Abdome
pale yellow, rather uniformly covered with abundant brownish tubercles and transverse
chitinized plates, these brown areas scarcer on pleura and not especially abundant on apica
margins of segments.

Pupa somewhat similar in general structure to pupa of Ptychoptera. Anterior cephali
crest small, lobules rounded, each tipped with a long, stout seta; immediately behind anterio
crest, a similar blunt, bilobed projection of front; laterad of crest, a slender, elongate tubercl
on either side, immediately behind antennal sheaths, each with a long seta; two other setiferou
tubercles on head behind antennae and maxillary palpi. Antennal bases approximate
between eyes. Sides of head, laterad of eyes, with a small setiferous tubercle. Maxillar
palpi not recurved at tip, as in Ptychoptera, ending opposite knee joint. Clypeus elongate
gradually narrowed toward apex, transversely wrinkled; two hairs toward base near inne
margin of eye. Each half of labium broad, roughly subquadrate, tips broadened an
obliquely truncated (Plate XVIII, 43).

Breathing horns almost as in Ptychoptera. (Nearly always it is the right horn that is elon
gated, but in about ten per cent of the specimens the left horn is elongated while the righ
is degenerated; Hart records one specimen in which both horns were developed, but unequally
the right measuring 23 mm. and the left 13 mm.; some of the specimens recorded by Ha
are larger than any that the writer has ever seen.) Wing sheaths ending almost opposite tip
of fore tarsi; media unbranched. Leg sheaths (Plate XVIII, 47) with fore tarsi much short

an the others and lying directly over middle tarsi; tarsi of hind and middle legs parallel nd extending beyond tips of fore tarsi. Scutal lobes each with about four setiferous tubercles. horax and first abdominal segment transversely crenulated.

Abdomen with transverse bands of chitin much broader than in Ptychoptera, so that they over almost the entire abdominal surface; these bands with about twelve tubercles on gments 3 and 4, about ten on segment 5, and from six to eight on the posterior segments; ubercles of various sizes, small and somewhat degenerate ones being interspersed with rger ones; tubercles long and slender, each crowned by a circlet or star of from three to x (usually four or five) stout spines (Plate XVIII, 44–46), a setiferous papilla arising om the center of this circlet of spines; spines on pleura longer than those on remainder of bdomen, but not arranged in distinct longitudinal rows as in Ptychoptera, being usually more regular, in some cases showing three or four more or less distinct rows; these pleural chitined areas usually bearing from two to four tubercles, which are closely approximated basally as to present a somewhat branched appearance. Male cauda (Plate XVIII, 48) as in tychoptera, but dorsal median lobe very short and stout; tubercles on segment immediately efore cauda long and slender, similar to those on remainder of abdomen.

Nepionotype.— Ithaca, New York, May 15, 1917.
Neanotype.— Orono, Maine, June 24, 1913.
Paratypes.— With the type pupa.

Malloch's figure of the pupa (1915–17 b:pl. 35, fig. 6) is diagrammatic. was probably made from a female individual, the antennal sheaths eing shorter in this sex than in the male.

FAMILY Rhyphidae

Larva.— Body eucephalous, amphipneustic. Mandibles opposed. Eyespots distinct. piracles on sides of prothorax. Thoracic and abdominal segments divided by false nstrictions. Spiracular disk surrounded by two or five lobes (Rhyphinae) or by four bes (Trichocerinae), or unprovided with lobes (Mycetobiinae).

Pupa.—Head with a bilobed setiferous cephalic crest. Palpi stout, straight. Pronotal breathing horns short, not prominent. Tarsal sheaths lying in pairs, one above other, the fore legs lying on the middle legs, and these latter on the hind legs. Lateral bdominal spiracles small but distinct.

The family Rhyphidae includes an apparently heterogeneous group genera which are in reality very closely related. The adults are of iverse appearance, but the immature stages are exceedingly similar to ne another and undoubtedly all three of the groups included in the mily are closely allied.

The immature stages of the Rhyphinae (Rhyphus) have been discussed y many entomologists, among others by Johannsen (1910:35–36,

Rhyphus punctatus) and by Malloch (1915–17b:243, *R. punctatus*). The larvae are often handsomely banded and mottled with brown or purplish. Johannsen and other authors describe the cauda as ending in two short lobes, but Malloch mentions five such lobes. The general structural characters are those described above for the family. The larvae occur in decaying vegetable matter, in manure (especially horse and cow dung), in sewage, and in similar material.

The Mycetobiinae are represented by Mycetobia, a curious fly which superficially resembles a mycetophilid rather than a crane-fly. Long ago Lyonet, Dufour, Guérin-Méneville and others described and figured the larva of Mycetobia and noted the eucephalous condition of the head and the amphipneustic spiracles. Osten Sacken (1863) first suspected the affinities of this genus with Rhyphus. More recently, work by Johannsen (1910:31–32), Malloch (1915–17a, and 1915–17b:244–245), Edwards (1916), Knab (1916), and others has definitely settled the relationship of this insect with the Rhyphidae. The larvae and the pupae agree closely with the general family characters discussed above. The larvae occur in decaying wood and about fermenting sap in wounds of trees. The genera Ditomyia Winn. and Symmerus Walk. are now placed in a separate family from Mycetobia, the Ditomyiidae (Keilin, 1919).

Until recently, the Trichocerinae have been considered as being members of the family Tipulidae. They include only the genus Trichocera, with about twenty-five nominal species, and, presumably, Ischnothrix Bigot, represented by a single species from Cape Horn. From the general appearance of the adult, these flies have usually been referred to the tribe Limnophilini, in a position near the genus Limnophila. Brunetti (1912) referred them to the Pediciini, and most other recent workers have accorded them tribal or subfamily rank in the Tipulidae. Bezzi (1914:214), influenced by the work of Keilin (1912), referred Trichocera to the Rhyphidae, but later (1918a:20) placed it back in the Tipulidae (as Limnobiidae). Malloch (1915–17b:234) likewise places Trichocera with the Tipulidae, but mentions the close resemblance of the larva to that of Rhyphus. The best discussions of the morphology of the larva and the pupa are those by Keilin (1912) and De Meijere (1916:191–194), both of whom were strongly impressed by the striking resemblance of the larva to that of Rhyphus. In the present paper, the Trichocerinae is the only group considered in detail.

SUBFAMILY Trichocerinae

Genus **Trichocera** Meigen (Gr. *hair* + *horn*)

1800 *Petaurista* Meig. Nouv. Class. Mouch., p. 15 (*nomen nudum*).
1803 *Trichocera* Meig. Illiger's Mag., vol. 2, p. 262.
1911 *Paracladura* Brun. Rec. Indian Mus., vol. 6, p. 286.

Larva.— Body eucephalous, amphipneustic. Thoracic segments divided into two annuli. Spiracles on lateral margin of posterior ring of prothorax. Abdominal segments divided into three annuli. Cauda ending in four lobes, ventral lobes the longer and more slender; lobes bearing numerous stout hairs near tips on outer face. Eyespots distinct. Lateral plates of head widely separated on midventral line. Mandible with prostheca distinct.

Pupa.— Cephalic crest small, lobes with stout setae. Clypeus short; labrum dumb-bell-shaped; palpal sheaths stout. Antenna elongate. Leg sheaths lying in pairs above one another, gradually lengthening, fore pair the shortest, posterior pair the longest. Pronotal breathing horns short. Abdominal spiracles small, but distinct and functional.

The small winter gnats of the genus Trichocera are rather familiar, since they are not rare during the winter months in cellars or even in the open on warm days, occurring in sunlit places in small, dancing swarms. They are abundant during fall and spring. They occur also in cool, shady places in summer, but are less in evidence at this season.

Trichocera is found somewhat commonly and regularly in mines, often at very considerable depths. Boheman (1850) records specimens of *T. vegelationis* in mines 600 feet below the surface, and Lampa (1890) also records the species as being found at considerable depths. Dr. H. B. Hungerford found numerous adults of a species of Trichocera in the Amethyst silver mine near Creede, Colorado, in 1914. Specimens that he obtained were taken at the sixth level, but the miners said the insects were to be seen in all parts of the mine; along the laterals at the sixth level they were noted 7000 feet from the entrance. It is supposed that these individuals breed in the animal waste which naturally accumulates in such places. Trichocera is also a characteristic inhabitant of caverns and grottoes, all stages being found in such situations (Schmitz, 1909:80; Bezzi, 1911–12:46–47, 49, and 1914:214).

The swarming and mating of these flies is well known. It has been ably described by Ainslie (1907), and is here discussed only in general terms. The insects swarm commonly in the autumn. Sometimes the swarms include but comparatively few individuals, but at other times many thousands participate. They swarm usually from five to twenty-five feet above the ground, all facing in the same direction, that is,

toward the wind or breeze. Mating takes place in the air, and united pairs then fly away or drop to the ground beneath. The swarms are often very dense, and individuals come in frequent contact with one another. When the breeze shifts, the swarm immediately readjusts its position and direction.

The immature stages of Trichocera are spent in decaying vegetable matter, beneath dead or decaying leaves, in débris, in fungi, and in similar situations. Sometimes the larvae and pupae are rather numerous in stored roots and tubers, especially potatoes, in which cases they may assume an economic importance (Johannsen, 1910:34–35; Carpenter 1912). The specimens used by the writer for study are part of Johannsen's material, determined as *T. regelationis* from Patten, Maine. The taxonomic condition of the group is such that no specific identification of the adult flies can be attempted at this time. The immature stages of the generalized subgenus of Trichocera, Diazosma Bergroth, are unknown.

The most important literature on the genus Trichocera is as follows:

Trichocera regelationis	General	Dufour, 1840:161.
Trichocera regelationis	Larva, general	Schmitz, 1909:80, pl. 8, fig. 3.
Trichocera regelationis	Larva, pupa	Johannsen, 1910:34–35, figs. 51–57.
Trichocera regelationis	Pupa	De Meijere, 1916:194.
Trichocera hiemalis	Larva, general	Curtis, 1846b.
Trichocera hiemalis	General	Cameron, 1917:63.
Trichocera fuscata	General	Carpenter, 1912. (Damage.)
Trichocera sp	Larva	Bremi-Wolf, 1846:175.
Trichocera sp	Larva	Perris, 1847:37, pl. 1, fig. 3.
Trichocera sp	General	Bezzi, 1911–12:46–47, 49.
Trichocera sp	Larva	De Meijere, 1916:191–194, figs. 21–23.
Trichocera sp	Larva, pupa	Keilin, 1912. (Morphology.)
Trichocera sp	Larva	Malloch, 1915–17b:234–235, pl. 26, fig. 1; 306.

Trichocera regelationis, supposition.

Larva.— Length, 8–9.5 mm.
Diameter, 1 mm.

Coloration pale brown in preserved material, whitish in fresh specimens.

Body rather short, cylindrical to slightly depressed (Plate XIX, 49). Pseudopods lacking. Head complete, non-retractile, strongly chitinized; lateral plates of head widely separated on midventral line, connected only by a narrow bridge posteriorly; chaetotaxy as shown (Plate XIX, 52 and 53). Mandibles opposed, of three parts, principal segments bearing on inner side near base an apparently movable appendage (prostheca) which has, besides the large apical tooth, three smaller teeth. Labrum bluntly rounded, with long hairs. Epipharynx with lateral combs of about six blunt teeth. Antenna two-segmented; basal segment

ry short, disk-shaped, inserted on a large brown-margined plate which is part of the head itin; second segment much narrower, egg-shaped; in addition to this segment there are veral small sensory papillae on the end of the first segment.

Segments of body divided into secondary annuli, thoracic segments with two such rings, dominal segments with three; annuli bearing transverse rows of short setae. Anterior iracles on posterior ring of prothorax near lateral margin conspicuous, smaller than posterior iracles but constructed on same general principle. Spiracular disk surrounded by four es; ventral lobes longer and more slender than dorsal pair, inner face narrowly chitinized, ter face densely clothed with abundant short yellow hairs (Plate XIX, 50 and 51); rsal lobes shorter and blunter, with short hairs on apices of outer face. Spiracles large, base of dorsal lobes.

Pupa.— Length, 7.5–7.8 mm.
Width, d.-s., 1.4 mm.
Depth, d.-v., 1.4 mm.

Coloration whitish; head, thorax, and sheaths of appendages brown.

Anterior cephalic crest small, lobes widely separated, each tipped with a long, stout seta ected ventrad; a tiny seta just behind each anterior lobe. Antennal bases above and ghtly between the eyes, bent dorsad and thence caudad, passing behind joints of legs, in female attaining to about one-third length of wing. Frontal region between eyes slightly nid, somewhat shiny. Clypeus short, the sides parallel, the apex U-shaped; labrum ad, dumb-bell-shaped, the caudal margin concave. Maxillary palpi very short and stout, ling before knee joints of fore legs (Plate XIX, 55). A small tubercle just laterad of e of antenna. Each cheek produced into a long, blunt, wrinkled tubercle.

Mesonotum (Plate XIX, 54) strongly gibbous, pale medially, narrowed in front, anterior rgin truncated and sending a sharp median carina cephalad; sides of mesonotum opposite g root with four small setae, in two slightly separated groups. Anterior angles of pro- um with a short bristle. Breathing horns small, short and almost straight, broad basally, cal half narrow, inner face fused or closely approximated with pronotum, apex cleft. ag sheaths attaining level of tips of fore tarsi; venation rather distinct. Leg sheaths with legs stout; fore tarsi overlying middle tarsi (Plate XIX, 55); middle tarsi overlying d tarsi; terminal segments of tarsi swollen. Abdominal segments divided into about ee false annuli; caudal margin of each segment fringed with short hairs. Tiny dominal spiracles on pleural segments. Female ovipositor (Plate XIX, 56) with the dorsal ves short, widely separated, acutely pointed; ventral acidotheca elongate, approximated, t slightly ventrad.

Larvae and pupae.— Patten, Aroostook County, Maine, May 3 and 23, 1907.

FAMILY Tipulidae

The family Tipulidae is the largest group of crane-flies, and possibly e only one to which the name is justly applicable. It includes a vast mber of species (nearly three thousand), arranged in about one hundred

and forty genera. The species are found in most parts of the world, bein restricted only by intense heat and cold. Crane-flies require moistur in order to complete their development, and, as a consequence, are almos always found in the neighborhood of flowing or stagnant water. N species known to the writer are inhabitants of desert conditions, th nearest approach probably being some Eriopterini, such as Helobi Trimicra, and other genera.

The immature stages frequent very wide ranges of habitat, which ar indicated elsewhere (page 716). They are readily separable from oth related species by the characters outlined on pages 744 to 758. Th subfamilies of Tipulidae may be separated by the following keys:

Larvae

1. Body provided with elongate spines or leaflike projections. **Cylindrotominae,** *pars* (p. 95
   Body without distinct spines.....
2. Form depressed, with more or less distinct lateral tubercles; terrestrial on spermatophyt plants.....**Cylindrotominae,** *pars* (p. 95
   Form terete; if depressed, without tubercles.....
3. Spiracular disk surrounded by six or eight lobes.....**Tipulinae** (p. 97
   Spiracular disk not as above.....
4. Spiracular disk surrounded by two, four, or five lobes.....
   Spiracular disk with three lobes or without distinct lobes.....
5. Head capsule massive, the hypopharynx a flattened plate with few teeth; size lar (aberrant Tipulinae).....
   Head capsule massive or dissected, if the former the hypopharynx not as above; si usually small.....**Limnobiinae,** *pars* (p. 79
6. Spiracular disk with five lobes; lives in moss.....Genus *Dolichopeza* Curt. (p. 98
   Spiracular disk with four slender, hornlike lobes; lives in earth. *Tipula selene* Meig. (p. 101
7. Size large (30 mm. or over); form very stout, terete; head capsule of the tipuline typ lives in wood.....Genus *Tanyptera* Latr. (p. 98
   Size small (20 mm. or under); form slender, terete; head capsule of the limnobiine type. **Limnobiinae,** *pars.* (p. 79

Pupae

1. Basal abdominal segments unarmed with teeth or spinous projections before posteri margin.....
   Basal abdominal segments armed with a transverse row of usually small teeth or chitino projections before posterior margin.....
2. Last larval skin adhering to posterior end, attaching pupa to a plant stem or a le coloration bright green.....**Cylindrotominae,** *pars* (p. 95
   Not as above.....**Limnobiinae,** *pars* (p. 79
3. Maxillary palpi curved or recurved at tips; size large, usually 12 mm. or over. **Tipulinae,** *pars* (p. 97
   Maxillary palpi not recurved at tips.....
4. Maxillary palpi long, slightly or decidedly curved at tips; size large, length usually 12 m or over.....
   Maxillary palpi short, straight; size small, usually 10 mm. or under. **Limnobiinae,** *pars* (p. 79

Dorsal abdominal segments with two slender spines before margin.
Cylindrotominae, *pars* (p. 959)
Dorsal abdominal segments with four or more teeth or spines before margin.
Tipulinae, *pars* (p. 974)

SUBFAMILY Limnobiinae

The subfamily Limnobiinae includes a vast assemblage of usually mall crane-flies. Only a few genera approach the ordinary size of the ther principal subfamily, the Tipulinae, such genera being Limnobia, 'saronius, Limnophila, Eriocera, Pedicia, and a few others.

The writer has endeavored to key the immature stages of tribes, subribes, and genera. As has been stated elsewhere, the keys are based lmost entirely on material seen by the writer, and additional specimens f other species will undoubtedly modify the arrangement very conderably. It is believed, however, that the keys as given will at least urnish suggestions or a basis for succeeding work. The characters iven in the keys, in so far as is possible, are those that can be seen without making a detailed dissection of the specimen. However, for most pecies it is necessary to study the larval head, as already outlined (page 41). The character of "head massive" or "head rodlike" can often e detected thru the larval integument without dissection. The spiacular disk is usually studied without especial difficulty.

The immature stages of the majority of the species are spent in moist arth, usually near water. Some are nearly, if not quite, aquatic (Antocha, lliptera, some Dicranomyia); others are fungicolous (Ula, some Limobia); several live under the bark of trees (some Dicranomyia, some hipidia, Discobola, Gnophomyia, Teucholabis, Elephantomyia, and thers); one, at least, mines in the leaves of plants (Dicranomyia).

The habits of the various genera and species are discussed in greater etail under the respective titles. The following keys separate the ribes and the subtribes of the subfamily Limnobiinae:

Larvae

. Spiracular disk provided with two long ventral lobes....2
Spiracular disk not as above....3
. Spiracles lacking or vestigial; mentum not completely divided medially; hypopharynx a chitinized double comb; species aquatic, in silken cases.
Limnobiini, subtribe *Antocharia* (p. 799)
Spiracles large, prominent, exposed; mentum completely divided medially; hypopharynx labriform....*Pediciini* (p. 894)
. Spiracular disk surrounded by four or five lobes....4
Spiracular disk surrounded by three lobes or without distinct lobes....19

4. Head capsule massive, compact, the posterior incisions usually shallow.....
Head capsule of four or six slender rods, the posterior incisions profound.....
5. Mentum completely divided, a toothed plate on either side; abdominal segments witho
distinct creeping-welts.....
Mentum, if present and chitinized, not completely divided; abdominal segments wi
basal creeping-welts.....
6. Spiracular disk squarely truncated, surrounded by five lobes..... *Eriopterini* (p. 9
Spiracular disk with four lobes.....
7. Each mental plate four-toothed; hypopharynx labriform.
Pediciini, subtribe *Adelphomyaria* (p. 8
Each mental plate with seven or eight teeth; hypopharynx a comblike ring.
Hexatomini, subtribe *Pseudolimnophilaria* (p. 8
8. Spiracular disk with five lobes.....
Spiracular disk with four lobes.....
9. Antennae almost globular, with two conical apical papillae; lives in fungi.
Hexatomini, subtribe *Ularia* (p. 8
Antennae elongate-cylindrical.....
10. Abdomen with dorsal and ventral creeping-welts; mentum with more than five teeth.
Limnobiini (p. 7
Abdomen with six ventral welts only; mentum with five or fewer teeth.....
11. Mentum five-toothed; lives in earth..... *Limnobiini*, subtribe *Rhamphidaria* (p. 8
Mentum three-toothed; lives in wood..... *Hexatomini*, subtribe *Epiphragmaria* (p. 8
12. Antennae almost globular, with two conical apical papillae; lives in fungi.
Hexatomini, subtribe *Ularia* (p. 8
Antennae elongate-cylindrical.....
13. Abdomen with dorsal and ventral creeping-welts, the latter naked; mentum not thr
toothed; forms aquatic..... *Limnobiini*, subtribe *Ellipteraria* (p. 8
Abdomen with ventral creeping-welts only; mentum with only three primary teet
species not aquatic.....
14. Form long, slender; skin naked, shiny, transparent; apical segment of antennae elonga
as long as, or longer than, basal segment; mentum with a smaller tooth on either sid
lives in earth..... *Limnobiini*, subtribe *Dicranoptycharia* (p. 8
Form short, stout; skin white, opaque; apical segment of antennae short, hemispheric
mentum without small lateral teeth; lives under bark.
Hexatomini, subtribe *Epiphragmaria* (p. 8
15. Blades of maxillae not produced; form long and slender.....
Blades of maxillae produced into flattened elongate appendages, the tips of which p
trude from the thoracic orifice when the head is completely retracted; form sh
and stout.....
16. Spiracular disk squarely truncated, surrounded by five lobes which are fringed wi
numerous, usually short, hairs; esophageal region not conspicuously grooved.
Eriopterini, subtribe *Eriopteraria* (p. 9
Spiracular disk surrounded by four lobes, each ventral lobe with a single elongate brist
esophageal region elongate, grooved; lives under bark.
Eriopterini, subtribe *Elephantomyaria* (p. 9
17. Mental region a narrow, transverse, chitinized bar.
Hexatomini, group *Limnophilae* (p. 8
Mental region not chitinized.....
18. Mandibles hinged; maxillae and labrum densely hairy; dorsal plates of head caps
united into a spatula..... *Hexatomini*, group *Ulomorphae* (p. 8
Mandibles not hinged; maxillae and labrum not densely hairy; dorsal plates of he
capsule separated..... *Hexatomini*, subtribe *Hexatomaria* (p. 8
19. Head capsule massive, compact.....
Head capsule of six slender rods; lives under bark.
Eriopterini, subtribe *Eriopteraria* (p 9

20. Mental plates not completely divided; abdominal segments with basal creeping-welts on both ventral and dorsal surface; spiracular disk indistinctly four- or five-lobed. *Limnobiini* (p. 795)
Mental plates completely divided; abdominal segments without welts; spiracular disk obliquely truncated. . . . . *Eriopterini* (p. 908)

Pupae

1. Pronotal breathing horns eight-branched; forms entirely aquatic. *Limnobiini*, subtribe *Antocharia* (p. 799)
Pronotal breathing horns simple, unbranched. 2
2. Rostral sheath elongated; lives in wood. . *Eriopterini*, subtribe *Elephantomyaria* (p. 952)
Rostral sheath not elongated. 3
3. Pronotal breathing horns very minute, conical, visible only with a lens.[5] *Limnobiini*, subtribe *Dicranoptycharia* (p. 828)
Pronotal breathing horns larger, not microscopic. 4
4. Dorsal spiracles on eighth abdominal segment large and functional. 5
Dorsal spiracles on eighth abdominal segment small or lacking. 7
5. A large circular spinous area on abdominal pleurites; cephalic crest chitinized, acutely pointed; pronotal breathing horns directed ventrad; lives in decaying wood. *Hexatomini*, subtribe *Epiphragmaria* (p. 843)
Not as above. 6
6. Pronotal breathing horns large, flattened, the tips yellow; abdominal tergites with shagreened crossbands. . . . . *Hexatomini*, subtribe *Ularia* (p. 838)
Pronotal breathing horns slender, cylindrical; abdominal tergites with tranverse rows of small spines. . . . . *Limnobiini*, subtribe *Rhamphidaria* (p. 830)
7. Abdominal pleurites with circular areas set with numerous microscopic spicules; pronotal breathing horns short, usually truncated at tips, which are margined with the breathing pores. . . . . *Pediciini* (p. 894)
Abdominal pleurites not as above, if with spines these large and few in number; pronotal breathing horns long, cylindrical. 8
8. Abdominal segments with broad transverse bands or welts on basal rings of third to seventh tergites. . . . . *Limnobiini* (p. 795)
Abdominal segments with basal ring unarmed as above, posterior ring before margin with a transverse row of spines or stiff setae. 9
9. A distinct crest on mesonotal prescutum armed with tubercles, spines, or setae; size small (usually under 9 mm.). . . . . *Eriopterini* (p. 908)
No distinct crest on mesonotal prescutum (scutellum armed in some Eriocera); size large (usually over 10 mm.). 10
10. Leg sheaths very short, barely exceeding wings; lives under bark. *Eriopterini*, genus *Gnophomyia* (p. 934)
Leg sheaths longer, extending one or more segments beyond tips of wings. 11
11. Size small (under 6 mm.); abdominal armature weak, lacking on segment 7. *Pediciini*, subtribe *Adelphomyaria* (p. 895)
Size larger; abdominal armature stronger, spinous; if small in size (Dicranophragma), basal annuli of abdominal segments armed with naked tubercles. . *Hexatomini* (p. 835)

Tribe Limnobiini

A large group of crane-flies, arranged in a few often extensive genera, comprise the tribe Limnobiini. At first sight the tribe appears to be a

[5] In the genus Cladura (Eriopterini), reared while this paper was going thru the press, the breathing pores are likewise microscopic, being entirely sessile (page 949).

heterogeneous assemblage, but in reality it constitutes a natural group. The tribe as herein arranged includes the old group Limnobiini, with the addition of several genera that were formerly distributed in the Antochini. The divisions of the tribe as now constituted are as follows:

1. Limnobaria — including the old tribe Limnobiini.
2. Ellipteraria — including the genus Elliptera. This is close to the preceding subtribe and may be a group belonging to it.
3. Antocharia — including Antocha and presumably allied genera, as Orimargula, Orimarga, Diotrepha, and possibly others.
4. Rhamphidaria — including Rhamphidia and its allies.
5. Dicranoptycharia — including Dicranoptycha only.

These groups are not far removed, phylogenetically, from the lowermost divisions of the Hexatomini, such as the Ularia and the Epiphragmaria, and the two tribes are unquestionably closer together than their arrangement on paper would indicate. The separation of the two major groups was made largely on the characters of the imagines.

The larvae have the body terete, moderately elongate or very long and slender (Dicranoptycha). The abdominal segments are subdivided into a basal and a posterior ring, the former with transverse welts of microscopic chitinized points or hooks. In the Limnobaria and the Antocharia these welts occur on both the dorsal and ventral surfaces in the form of microscopic hooks; in the Ellipteraria they are on segments 3 to 9 on the dorsal surface only, being indicated on the ventral surface but naked; in the Rhamphidaria the welts are ventral in position on segments 2 to 7; in the Dicranoptycharia they are similar, on segments 2 to 8. The body in Dicranoptycha is entirely glabrous.

The head capsule is of moderate to large size and is massive and compact, consisting of a narrow dorsal plate which is usually indented behind, and two broad mussel-shaped lateral plates which are connected anteriorly across the venter to form the mental plate. The mental plate consists of an outer plate which usually terminates in a single median point, and behind this an inner plate which contributes additional teeth to the mentum. In Dicranoptycha there is but one subequal tooth on either side, with an additional much-reduced tooth; in Rhamphidia there are two teeth, and in the other groups there are usually four or five. The hypopharynx is usually a double plate united at the ends to form a collar, with the anterior margins finely toothed. The maxillae are

arge and simple in structure; the cardo and stipes are large; the palpus is lattened. The antennae have the apical segment or papilla ranging from longate, in Dicranoptycha, to very flattened and disklike, in Limnobia nd its allies. The mandibles are usually of simple structure, with one or wo dorsal teeth and from three to seven teeth in the ventral cutting ow.

The spiracles are lacking in some species, at least, of Antocha. The piracular disk is surrounded in Rhamphidia by five subequal lobes, in Dicranoptycha by four slender, naked lobes; in many Limnobaria the lobes re lacking or indistinct.

The larvae of many of the species are able to spin silken cocoons or ubes in which they live. These tubes are open at both ends, and are sually covered exteriorly with particles of extraneous matter gathered n the larval haunts.

The pupae usually lack a distinct setiferous cephalic crest, altho one s present in Rhamphidia and in Dicranoptycha. The pronotal breathing orns are usually large, and are either subcircular, or wider than long (most Limnobaria), rarely elongate (Rhamphidaria), very large, earlike, and ontiguous or practically so on the median line (Ellipteraria), or branched nto eight long filaments (Antocharia); in the Dicranoptycharia, how- ver, they are microscopic. The abdominal segments on the basal ring ften show a transverse welt of small hairs or a double convergent row of hitinized hooks; in Discobola, Rhamphidia, and Dicranoptycha, how- ver, this is apparently not the case, the abdominal armature being more riopterine or hexatomine in appearance. The eighth abdominal seg- ient often bears a pair of dorsal spiracles; these are apparently lacking n some species (*Antocha saxicola*) and are small in most Limnobaria, but re large and functional in Rhamphidia.

The following keys separate the subtribes of the tribe Limnobiini:

Larvae

. Body ending in two long ventral lobes; spiracles lacking or very reduced; forms strictly aquatic ..... *Antocharia* (p. 799)
Body not as above; spiracles large 2
. Body with ventral and dorsal welts on abdominal segments 3
Body with ventral welts only 4
. Spiracular disk surrounded by four lobes which are provided with long fringes of hair; dorsal welts microscopically spiculose; ventral welts naked; species aquatic. *Ellipteraria* (p. 806)
Spiracular disk not as above; dorsal and ventral welts alike ..... *Limnobaria* (p. 808)

4. Body moderately elongated, covered with a long, dark pubescence; abdomen squarely truncated at end, surrounded by five lobes, presenting an eriopterine appearance; mentum conspicuously five-toothed ..... *Rhamphidaria* (p. 830)
Body very long and slender, glabrous; abdomen surrounded by four narrow, glabrous lobes; mentum indistinctly five-toothed ..... *Dicranoptycharia* (p. 828)

Pupae

1. Pronotal breathing horns branched; forms entirely aquatic ..... *Antocharia* (p. 799)
Pronotal breathing horns simple 2
2. Pronotal breathing horns very tiny, microscopic, conical ..... *Dicranoptycharia* (p. 828)
Pronotal breathing horns large, conspicuous 3
3. Pronotal breathing horns large, earlike, contiguous basally; forms aquatic, in silken cocoons ..... *Ellipteraria* (p. 806)
Pronotal breathing horns not contiguous basally 4
4. Cephalic crest small or lacking; pronotal breathing horns short and broad, rarely elongated; a pair of small spiracles on dorsum of eighth abdominal segment ..... *Limnobaria* (p. 808)
Cephalic crest large, setiferous; pronotal breathing horns long and slender, cylindrical; a pair of large spiracles on dorsum of eighth abdominal segment.
Rhamphidaria (p. 830)

The most important literature on the tribe Limnobiini is as follows:

Antocha saxicola	General	Needham, 1908a:205.
Antocha sp	Larva	Malloch, 1915–17b:236–237.
Elliptera omissa	Larva, pupa, general	Mik, 1886b.
Elliptera omissa	Larva, pupa	Grünberg, 1910:31–32. (Copy.)
Elliptera omissa	Larva, pupa	Malloch, 1915–17b:226–227.
Thaumastoptera calceata	Larva, pupa, general	Lenz, 1920a.
Limnobia quadrimaculata	General	Von Röser, 1834 (as *annulus*).
Limnobia quadrimaculata	Larva, pupa	Beling, 1873b:590–591 (as *annulus*).
Limnobia bifasciata	Larva, pupa, general	Bremi-Wolf, 1846 (as *xanthoptera*).
Limnobia bifasciata	Larva, pupa, general	Pastejrík, 1909 (as *xanthoptera*).
Limnobia bifasciata	Larva, pupa	De Meijere, 1916:198–201.
Limnobia decemmaculata	General	Loew, 1873:41.
Limnobia decemmaculata	General	Verrall, 1912.
Limnobia flavipes	Larva	Beling, 1886:202.
Limnobia inusta	General	Beling, 1886:202 (as *macrostigma*).
Limnobia sexpunctata	Larva	Beling, 1879:54–55 (as *nigropunctata*).
Limnobia nubeculosa	General	Beling, 1879:56.
Limnobia obscuricornis	Larva, pupa	Beling, 1879:55–56.
Limnobia tripunctata	Larva, pupa	Beling, 1873b;591–592.
Limnobia triocellata	Larva, pupa, general	Johnson, 1906:2.
Limnobia triocellata	Larva, pupa	Malloch, 1915–17b:215–216.
Limnobia immatura	Pupa	Malloch, 1915–17b:216.
Libnotes perkinsi	General	Perkins, 1913:clxxxii (as Limnobia).
Discobola caesarea	Pupa	Mik, 1884.
Dicranomyia trinotata	Larva, pupa	Thienemann, 1909.
Dicranomyia trinotata	Larva, pupa	Grünberg, 1910:29. (Copy.)
Dicranomyia dumetorum	General	Winnertz, 1853.

ranomyia dumetorum	General	Beling, 1873 b: 592.
ranomyia dumetorum	General	Beling, 1879: 56.
ranomyia dumetorum	Larva	Beling, 1886: 201–202.
ranomyia sp.	General	Schubart, 1854.
ranomyia foliocuniculator	General	Swezey, 1913.
ranomyia foliocuniculator	Larva, pupa	Swezey, 1915: 87.
ranomyia umbrata	Larva	De Meijere, 1916: 197–198.
ranomyia simulans	Larva, pupa, general.	Needham, 1908 a: 214–217.
ranomyia simulans	Larva, pupa	Malloch, 1915–17 b: 213–214.
pidia maculata	Pupa	Beling, 1873 b: 592.
pidia maculata	Larva, general.	Beling, 1879: 52–53.
pidia uniseriata	Larva, general.	Beling, 1879: 53–54.
pidia domestica	General	Johnson, 1910: 704.
ranoptycha winnemana	Larva, pupa	Alexander, 1919 b.
mphidia longirostris	General	Gercke, 1884.
mphidia longirostris	General	Grünberg, 1910: 30. (Copy.)
mphidia flavipes	Larva	Hart, 1898 [1895]: 197–199.
mphidia flavipes	Larva	Malloch, 1915–17 b: 231–232.

Subtribe **Antocharia**

The subtribe Antocharia includes the genus Antocha and probably ee or four related genera, such as Diotrepha, Orimarga, and Orimargula. e group is well-defined in all stages, so far as these are known, the vae presenting a curious superficial resemblance to those of Pedicaria, ile the pupae introduce a novelty of structure of the breathing horns, ch is discussed in detail elsewhere (page 805). It is probable, however, t these peculiarities of larval and pupal structure are largely the result abit and habitat, and a critical survey of the structure shows a close tionship with the other subtribes herein recognized.

ius **Antocha** Osten Sacken (Gr. *close approximation*)

1859 *Antocha* O. S. Proc. Acad. Nat. Sci. Phila., p. 219.

rva.— Body slender, tapering behind, ending caudally in two elongate ventral lobes h bear a few hairs at their tips and at intervals along their length. Abdominal segments 7 each with a swollen area on basal ring densely covered with microscopic hairs. heal gills four in number, large, constricted into three or four lobes. Spiracles lacking idimentary. Head capsule moderate in size. Mentum with nine or ten teeth, deeply behind. Maxilla conspicuous, consisting of two subequal lobes which are provided with e brushes of hairs. Hypopharynx with chitinized teeth.

upa.— Anterior end of body large, tapering behind. Head with a small median lobe ront, on either side of which is a small tubercle; genae gibbous. Pronotal breathing s large, flattened, the margin branching into eight long filaments. Abdominal segments asal ring with a double transverse row of small hooks which converge at the ends to inclose val depressed area; last segment of body terminating in two strong, recurved, chitinized s.

Antocha is a small genus of crane-flies (about seven species) who specific limits are still not well understood. The species are well di tributed thruout the Northern Hemisphere. The adult flies are of prin itive organization, but the larvae and the pupae are highly specializ in many respects.

The only previous record of the immature stages of any member of th group is the unknown Limnobiine No. 2 (Malloch, 1915–17b: 236–237), whi surely refers to an Antocha, possibly *A. monticola* Alex. The main poi of difference between the species described by Malloch and the speci described in detail hereinafter is the small spiracles mentioned in th description of the former species. *A. saxicola* lacks spiracles, since has no use for them, being confined to submerged cases often many fe below the surface of the water.

Altho nothing is known concerning the immature stages of the gene Orimargula, Orimarga, and Diotrepha, the writer believes that the genera will be found to have larvae of this same general type, since fro the structure of the adults they are obviously derived from the Antoc stem. The larvae are curiously suggestive of the Pediciini (as compare with Dicranota), but the structure of the mouth parts, the smooth pseud pods, and the cauda, are quite different and indicate that the similariti are analogous only. The pupae are unlike those of any crane-fly as y made known, in the very remarkable breathing horns; but this is possib a condition brought about by the habitat rather than a fundamen feature. The apparently very different pupae of Elliptera are close related to Antocha.

Antocha saxicola O. S.

1859 *Antocha saxicola* O. S. Proc. Acad. Nat. Sci. Phila., p. 219.

Antocha saxicola has one of the most interesting life histories of any the crane-flies yet discovered, not only because of the larval and pup habitat, but also because of the peculiar structures that appear in th larva and in the pupa and have been found nowhere else in the immatu stages of the family, so far as is known. The larvae simulate striking the same stage in the Pedicaria, but are apneustic, entirely lacking fun tional spiracles and depending wholly on tracheal gills for their respir tion. The pupae have the pronotal breathing horns split into eight lo filaments, so that they bear a curious superficial resemblance to the pup

of the black fly (Simuliidae). Both larvae and pupae spend their entire lives in cases on stones in water — usually in running, well-aërated water, and often in the most rushing torrents.

The larvae, as already stated, lack spiracles, the entire respiration being carried on thru tracheal gills, four in number, and the rich tracheal development in the elongate caudal lobes. Thus the tracheal system is truly closed, and represents the maximum of specialization in the reduction in size and final loss of the spiracles. In air-breathing, terrestrial forms, the spiracles are large and situated comparatively close together, gradually becoming smaller and more removed from one another as the creature becomes more and more dependent on blood gills or tracheal gills for respiration. This is the only truly closed tracheal system known to the writer to occur in the Tipulidae. It should be noted that the loss of the spiracles is accompanied by great enlargement of the gills and the taking on of the gill function by the two caudal lobes. The haunt of the larvae is in silken cases on rocks, often in the swiftest part of the stream, where it is impossible to breathe thru spiracles and where the associated forms of life (Ephemerida, Plecoptera, Trichoptera, and Diptera) all, or practically all, depend entirely on gills for respiration.

As a rule, the larval cases are made on rubble or rounded stones, a crevice or a groove caused by inequalities of the rock surface covered over being the simplest and commonest place chosen. The inequalities in the rock are bridged over by a silken, mud- or silt-covered case, which is very delicate and laterally fimbriated with the young larva but becomes much firmer, thicker, and more compact with the older larva and pupa. The larval case is open at both ends and the larva passes backward and forward freely, showing considerable agility when disturbed. When the larva is still small, the case is correspondingly small and insignificant; but the case of the matured larva is conspicuous, measuring from 4 to 5 centimeters in length and about 1.2 centimeters across the lateral "wings," or fimbriations. The insect moves freely along the tube but is very loath to leave it unless actually ejected. As stated above, the late larval and pupal covering is very different from the flimsy, silt-covered tube of the young larva, being smooth, compact, hard, and often covered with pebbles. The pupa has two powerful hooks at its caudal end, enabling it to fasten to the case. In most cases the pupa hangs with the current, head downstream, like the pupa of Blepharocera

and unlike the somewhat similar-appearing pupa of the Simuliidae, which rests with the head upstream, against the current, the pupal case being open at the cephalic end only.

These curious larvae were first noted at Ithaca, New York, in mid-April, in Cascadilla Creek. They were common in situations such as described above. Larvae were found thruout most of April, May, and June; they would probably be seen in somewhat fewer numbers thru most of the summer season, since the adult flies have a long seasonal appearance. The first pupa was found on May 15, 1917, but the season that year was very backward and undoubtedly the species pupates earlier in more nearly normal seasons.

In Cascadilla and Fall Creeks, at Ithaca, the immature stages of Antocha are usually associated with a fauna of rapid-water (lotic) forms, the following being the more notable and constant:

Planarians.	*Planaria* sp.
Ephemeridae.	Nymphs of Baetis, Leptophlebia, Ephemerella, Ecdyurus, Epeorus, Iron, Heptagenia, Chirotenetes, and others.
Perlidae.	Nymphs of Pteronarcys, *Perla immarginata* Say, Acroneuria, Neoperla, and others.
Trichoptera.	Larvae and pupae of Helicopsyche (abundant), Hydropsyche, Hydropsychodes, Ithytrichia, Rhyacophila, Leptocerus, Polycentropus, and others.
Lepidoptera.	Larvae and pupae of Elophila.
Coleoptera.	Larvae of Psephenus.
Diptera.	Larvae and pupae of Blepharocera, Simulium, Orthocladius, Tanytarsus, and others.

Early in spring the rocks are plastered with dense coatings of Diatomaceae (Navicula, Synedra, Meridion, and other genera), which later in the season become much rarer or disappear entirely. It is often impossible to tell the case of Antocha from that of some very similar caddisworm cases, especially some of the glossosomatine Rhyacophilidae. Dr. Noyes found larvae of Antocha in a small, rapid-flowing stream near Ringwood Hollow, and here the cases were covered with tiny pebbles and it was quite impossible to distinguish them superficially from associated caddis-worm cases. In Cascadilla Creek the little cases of Helicopsyche often plaster the upper surfaces of submerged rocks, and the writer has found tubes of Antocha that were almost buried beneath these cases.

Antocha is by no means confined to rapidly flowing streams, altho
e insects are very often found in such situations. The writer has found
ults in his tent traps set over the Sacandaga River, in Fulton County,
ew York, where the water was very quiet and at least ten feet deep.
eedham (1908a:169–170, 205), similarly, found adults in numbers in
s tent traps set over Beaver Meadow Brook at Old Forge, New York,
August, 1905, but did not locate the larvae. In rapid-flowing streams
e insects sometimes occur just at the surface in a few millimeters of
ater, or at greater depths. The immature stages seem adapted to live
der almost any conditions of current, from moderate pressure to sit-
tions where the water rushes by in torrents and where but few of the
ual lotic organisms, such as Blepharocera, Simulium, Psephenus, and
hers, can exist. From Clemens' studies (1917:14–23) it is evident that
e current is much more rapid just beneath the surface than at various
wer depths, so that at a depth of one foot the current velocity is only
out two-thirds of that at the surface. Thus these aquatic organisms are
t constantly and entirely subjected to such tremendous pressures as
first sight they appear to be. Many of the larvae and pupae perish
m desiccation, due to the lowering of the stream level and the conse-
ent exposure of the rocks on which their homes are made.

Copulation between the adult flies takes place on the exposed rocks
and along the margins of the streams where the larvae live (Osten
cken, 1869:127). The eggs are deposited in the water, and the entire
, until the emergence of the adult fly, is spent beneath the water. The
ole life cycle may require a year, altho the species is possibly double-
ooded. At a single time, and even on a single rock, larvae of various
es, from very small ones to those almost fully grown, may be found,
d this probably explains the long flight-period of the adult. That the
ecies is double-brooded remains to be proved.

The food of the larva consists of microscopic plant organisms in the
ter, the curious maxillae, with their dense brushes of long hairs,
doubtedly being an adaptation for this type of food.

Larva.— Total length, 9.5–10.5 mm.
Length of caudal lobes alone, 1.1–1.2 mm.
Diameter of body, 1–1.1 mm.

Coloration of living larva, light greenish brown above, clearer greenish ventrally; contents
alimentary canal showing clearly thru the thin skin; on segments 7 and 8, two paired, bright

orange bodies which are very conspicuous, these possibly being fatty in nature; welts on th abdomen dark brown; in preserved specimens general coloration fading to a dull yello

Form elongate (Plate XX, 57), tapering behind. Surface with a dense, appressed pube cence and scattered erect hairs. Prothorax long, narrowed in front, anterior orifice margine with dense, fine pubescence; sides of prothorax with numerous long, erect, pale hair Mesothorax and metathorax indistinctly divided into two approximately equal annu anterior annulus with a few lateral setae. First abdominal segment short, the setae arrange as follows: dorsal, two small grouped setae near posterior margin, laterad of each of thes but in alinement, a solitary stout seta, proximad of each of these a stout seta, and cephal of each of these another strong seta, the principal setae of each side thus forming a roug triangle; a long, delicate pleural seta on each side; ventral, two small groups of setae, wit an arrangement similar to that of the grouped setae of dorsum. Abdominal segments 2 to each indistinctly divided into two annuli by a transverse constriction, the anterior ring abo half the length of the posterior ring and bearing medially a transverse elongate-oval (dorsa to short-oval (ventral) welt, covered with microscopic points; ventral welts very conve and swollen; pleura with a long seta; posterior ring with setae arranged as described abov for first abdominal segment; setae of posterior segments of body longer, but occupying sam relative position; small solitary inner seta of dorsal posterior line becoming large and pron inent on seventh segment; segment 8 with six powerful setae in alinement on ventral surface situated at base of gills, two being pleural and four ventral in position; dorsum of segmen 8 with a rounded median lobe. Gills four, long, delicate, divided into lobes by constriction (the two caudal lobes, as well as the gills, have taken on a respiratory function). Cauda ventral lobes two (Plate XXI, 68) very long, parallel, with scattered setae arranged as fo lows: at tips, six or seven; at about two-thirds length, three; at about one-third length, a tu of from fifteen to twenty long and short setae on lateral and dorsal faces; a small solitary set dorsal in position, at base of lobe; a similar bristle on ventral face at about midlength of lob Like remainder of body, cauda covered with an abundance of delicate appressed pubescence on dorsal side, at base of each lobe, a rounded spot, and just inside this a narrow, longitudina line which is destitute of pubescence. Only dorsal lobe the median one of eighth segmen mentioned above. Spiracles lacking.

Head capsule (Plate XX, 58) moderate in size. Lateral plates thin, double, inner one th longest, outer one forming mental plate. Dorsal plate broad in front, narrowed behin posterior margin bluntly notched; in front of this plate, two broad plates, rather widel separated medially, presumably belonging to clypeus. Labrum broad, cephalic margin an ventral face with transverse rows of short hairs. Mentum (Plate XX, 59) conspicuous, deepl split behind but not entirely divided as in the Pediciini; an outer flattened, circular media lobe whose outer face is covered with small, scalelike roughenings; behind (dorsad of) th outer lobe the mentum proper, roughly triangular in outline, conspicuous, margin with broad, blunt, median tooth which is sometimes (Plate XXI, 66) bilobed to form two subequ apical teeth; besides this median tooth, four lateral teeth, the outermost one broad with i lateral angle rounded. Hypopharynx (Plate XXI, 64) forming a ring into which ducts of sal vary glands open; anterior part, somewhat resembling mentum in shape, a narrow blad with anterior margin having about eight teeth; posterior part a transverse, arcuated ban with anterior margin having about twenty teeth. (In the figure, the two parts of the hyp

arynx are shown diagrammatically and separated; in some specimens the lateral teeth are re acute, in others they are more rounded.) Antenna (Plate XXI, 65) elongate, cylindrical, tinized, apex pale, with two long, sensory setae and a few papillae. Mandible (Plate XXI, and 67) strong, flattened, with two powerful bristles on back, or scrobal region, near se; inner face concave, tip ending in a long tooth, dorsad of apex a single smaller tooth, ntral cutting edge with four gradually smaller teeth, beyond the last of which the margin crenulated into four or five indistinct carunculations; viewed from inside, lateral teeth pearing blunt. Maxilla (Plate XXI, 63) large, consisting of two elongate-oval lobes, the er one densely hairy; palpus, borne at tip of outer lobe on ventral face, shaped like one-f of a cylinder split lengthwise, several tiny hyaline sense pegs at apex; laterad of palpus l nearer base of outer lobe, a small elongate sensory tubercle with hairs at apex; inner e of maxilla subequal in size and length to outer lobe, but more densely hairy; on its ventral e, four or five long sensory tubercles which are expanded at their ends into setiferous heads; base of maxilla, a long, slender arm with three setiferous punctures at apex and another ncture at about two-thirds length; setae of this arm very long and delicate. (A dorsal w of the larva is shown in Plate XX, 57.)

Pupa.— Length to tip of cephalic crest, 6.2–6.8 mm.
Width, d.–s., 1.4–1.5 mm.
Depth, d.–v., 1.1–1.2 mm.

Head, thorax, and sheaths of appendages dark brown in fully colored individuals; abdomen e yellowish white; terminal hooks of abdomen heavily chitinized.

Head on margin above eyes with a blunt median lobe and on either side a small but prom-nt tubercle; gena gibbous. Compound eyes large, semicircular in outline. Front between s with margins almost parallel. Labrum with apex truncated or indistinctly bilobed. ial lobes broad, appearing subtriangular. Sheaths of maxillary palpi not greatly gated, slender, cylindrical.

Pronotal breathing horns (Plate XX, 61) flattened at base, each arcuated basally behind, ding laterad to form a concave hollow in front; base dark brown, chitinized, branched eight long, pale filaments which are grouped more or less in pairs; the two ventral and four dorsal filaments arising from a short common base, the other two being separate their entire length; these filaments as long as, or longer than, antennal sheaths, varying ength from rather short to a longer type. Thoracic dorsum broad, ample, feebly wrinkled nsversely. Leg sheaths (Plate XX, 60) with all the tarsi very long and slender, reaching ost to end of fifth abdominal segment. Wing sheaths comparatively narrow, reaching e of third abdominal segment; anal angle sharp; venation fairly distinct.

Abdomen pale. Intermediate abdominal segments divided into two annuli, the posterior much the larger; dorsa of segments 3 to 6 (Plate XXII, 71), and sternum of segment ach with basal annulus tumid and with two transverse rows of small hooks converging at ends to inclose a linear depressed area; these areas capable of contraction, so that the ks of each row are united or approximated with those of the opposite row; from thirty hirty-five hooks in each row, anterior row with hooks directed backward, posterior row h hooks directed forward; on seventh segment, only the anterior row of hooks present, very htly arcuated, the lateral hooks smaller than those near middle of row; caudad of this

row on segment 7, a darkened, transversely rectangular area bearing setiferous punctu in two broken rows, the posterior row the more complete; posterior rings of other segme of dorsum bearing setae in somewhat the same arrangement. Pleural area pale, segme 2 to 8 with a long, delicate seta on each annulus. Dorsum of segment 8 (Plate XXII, 70) w a large setiferous tubercle on either side, this tubercle densely covered with hairs that longest behind and shorter in front; caudad of these large, blunt knobs, a slender, setifer tubercle. Last segment with tergal valves chitinized, elongate, extreme posterior mar rounded medially and feebly bilobed, lateral angles produced caudad and dorsad into pow ful curved, heavily chitinized hooks; a few setae at about midlength of these ho (Plate XX, 62). Sternal valves shorter, slightly bilobed medially.

Nepionotype.— Ithaca, New York, June 4, 1917.
Neanotype.— With the nepionotype.
Paratypes.— Topotypic, May 1 to June 10, 1917.

Subtribe **Elliptera**ria

The present knowledge of the immature stages of the genus Ellipte is due entirely to the work of Mik (1886 b). From his rather detail description and figures, it certainly appears that the group should recei coordinate rank with Antocharia, Limnobaria, and other divisions her created. The genus Elliptera shows peculiarities of structure in all stag but many features of its organization remind one forcibly of species Dicranomyia (such as *D. simulans* and *D. trinotata*) on the one hand, a of Antocha on the other; and it may be that the genus Elliptera stands closer relationship to Dicranomyia than is now believed.

Genus **Elliptera** Schiner (Gr. *I omit,* or *ellipse* + *wing*)

1863 *Elliptera* Schin. Wien. Ent. Monatschr., vol. 7, p. 222.
1913 *Ellipoptera* Bergr. Ann. Mag. Nat. Hist., 8th ser., vol. 11, p. 576 (corr spelling).

Elliptera is a small genus, including but five species which have a d continuous range, two being found in Europe and three in western Nor America. The commonest of the North American species, *E. clar* O. S., was found on wet moss in the spray of Vernal Falls, Yosemite Valle California (Osten Sacken, 1877:198). The only information available the immature stages of a member of this genus is that furnished by M (1886 b) on the European species *E. omissa* Egg. (quoted subsequent by Grünberg, 1910:31–32, and by Malloch, 1915–17 b: 226–227). T description and account as given below are based entirely on Mi paper.

Elliptera omissa Egg.

1863 *Elliptera omissa* Egg. Verh. Zool.-Bot. Ges. Wien, vol. 13, p. 1108.

Specimens of *Elliptera omissa* were found by Mik (1886 b) along watercourses and near falls in mountainous regions. The adult flies were noted as late as September 10, swarming about the waterfalls.

Larvae and pupae were found on July 30 and August 17 near Salzburg, Upper Austria, living in elongate and somewhat depressed cocoons about 10 millimeters long and 4 millimeters broad which were arranged in longitudinal rows with short spaces between. These cocoons, which were placed with the current, occurred on the wet walls of wooden chutes or runways and also on dripping chalk cliffs. The immature stages spend their existence in these small cocoons of mud and silk. When ready to emerge as an adult, the pupa makes its way thru the end of the cocoon away from the current, leaving the cast skin attached to the opening. The margins of the large pronotal breathing horns of the pupa are finely serrated and are presumably used in making this opening thru the cocoon. The young larva probably creeps about on the floor of the runway, feeding on algae growing in the same situation. When nearly full-grown, the larva crawls to a less exposed place and spins its cocoon. Many larvae and pupae are killed by the drying-out of their haunts when the water supply becomes insufficient to cover them.

Larva.— Length, 7 mm.
Diameter, 1.5 mm.

Body clearly depressed (Plate XXIII, 72), greenish white, scarcely shiny, with delicate appressed grayish hairs which are thicker at the two ends of the body, especially on last segment, where they become almost villous. Integument very transparent, so that intestine and contents show thru, the intestine narrowing on segment 6 and thru to segment 8, where it broadens out and almost entirely fills the ninth and tenth segments. On sides of prothorax a delicate, long, pale hair; on remaining segments two such hairs. On each of abdominal segments 3 to 9, on dorsum near anterior margin, a low transverse ridge which is thickly set with short, blackened points; on sternum of each of same segments, a similar belt which is destitute of points. In male larvae, clawlike appendages of genitalia of adults showing thru skin on ventral side.

Head capsule (Plate XXIII, 73 and 74) massive, slightly longer than broad, black, somewhat shiny, all the sclerites compact and closely united; anterior projecting part of capsule with margins transparent, rust-brown; median part with two small knobs, laterad of which are two larger projections which are crowned with short points; capsule weakly keeled behind on dorsum (Plate XXIII, 74), anterior to which are two swollen elevations; on hinder margin of clypeus a styliform, bristly lobe, easily broken off, which is presumably the antenna.

Labium strongly chitinized, triangular, split longitudinally. Mandible (Plate XXIII, 75) clawlike in appearance, a little smaller than either half of labium, on inner face with a chitinized projection which is serrated. Maxilla indistinct, the palpi coroniform. Spiracular disk (Plate XXIII, 77) with four lobes whose inner faces are narrowly lined with black chitin, lobes provided with lashes of long gray hairs; dorsal lobes the shorter and broader, and bearing on their inner face two elongated stigmata which are margined with pale rust-yellow.

Pupa.— Length, 6.5 mm.

Pronotal breathing horns (Plate XXIII, 76) large, ear-shaped; bright yellowish white in color, in contrast to dirty yellowish brown skin of head, thorax, and appendages; each horn consisting of two parts: the dorsal side, appearing smooth and homogeneous; and the ventral side, with two longitudinal furrows converging toward apices, and with abundant elongate tubercles, under low magnification this part appearing pitted because of the spaces between these tubercles. Margin of breathing horn chitinized and very finely notched. On outer basal part of each ear a parchment-like lobe, which joins ear to side of prothorax; in addition to this, each ear at base is drawn out into an almost rectangular lobe which is closely approximated to pronotum. Leg sheaths extending about to base of fifth abdominal segment. Abdomen distinctly depressed, greenish white in color; segments 3 to 7 on both dorsum and sternum near base with a double cross-row of spicules which present a comblike appearance (Plate XXIII, 78), those on dorsal segments being somewhat stronger. Female pupa with acidothecae grown together on inner face, at outer angle of each a chitinized hook which is curved upward. Male pupa with ventral side of last segment produced into two chitinized points which are bent toward each other and almost touch, these inclosing clasping organs of adult male and hooks of male larva as described above.

Subtribe Limnobaria

The subtribe Limnobaria includes about ten genera, which are very closely related to one another and whose limits are as yet not clearly defined. Many of the generic distinctions are based on male characters of wing form, venation, or antennal structure. The genera are often very large and it is difficult to give satisfactory characters to separate their immature stages. The keys to the genera, given below, will unquestionably need much revising when a larger number of forms are studied.

Larvae

1. Form stout; teeth of mandibles and of mentum usually more numerous; mentum more pointed anteriorly ..... *Limnobia* Meig. (p. 809)
   Form usually more slender; teeth of mandibles and of mentum usually fewer; mentum transverse or subtransverse .....
2. Mandibles very broad, flattened, with three ventral cutting teeth; mentum about transverse, with nine or eleven teeth ..... *Rhipidia* Meig. (p. 825)
   Mandibles more slender, with usually four or five cutting teeth; mentum usually a little pointed anteriorly, with about eleven teeth ..... *Dicranomyia* Steph. (p. 819)

Pupae

. The five basal abdominal segments on both dorsum and venter with a comb of small, blunt teeth; wing sheaths showing an ocellate pattern; pupae living beneath bark of coniferous trees ..... *Discobola* O. S. (p. 815)
Abdominal segments provided with basal transverse welts of microscopic points on segments 3 to 7; wing pattern not ocellate 2
. Pronotal breathing horns long and narrow, about three times as long as broad. *Rhipidia* Meig. (p. 825)
Pronotal breathing horns short and broad, length and breadth not greatly different. . . . 3
. Size large (usually over 10 mm.); breathing horns often broader than long. *Limnobia* Meig. (p. 809)
Size smaller (usually under 10 mm.); breathing horns usually as long as broad. *Dicranomyia* Steph. (p. 819)

Genus **Limnobia** Meigen (Gr. *swamp* + *I live*)

1800 *Amphinome* Meig. Nouv. Class. Mouch., p. 15 (*nomen nudum*, preoccupied in Annelida).
1803 *Limonia* Meig. Illiger's Mag., vol. 2, p. 262.
1818 *Limnobia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 116.
1818 *Unomyia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 116.
1856 *Limnomyza* Rond. Dipt. Ital. Prodr., vol. 1, p. 185.

Larva.— Form stout, terete. Abdominal segments with dorsal and ventral transverse welts covered with chitinized points on basal rings. Spiracular disk surrounded by indistinct lobes, the spiracles large. Head capsule large, massive, the dorsal plate narrowed behind and more or less bifid at its tip. Labrum transversely oval, with sensory bristles near margin. Mandible blunt, with from four to seven cutting teeth. Maxilla simple, cardo and stipes large. Antenna with apical papilla button-like. Mentum broad, margin with from eleven to thirteen teeth. Hypopharynx a circlet of two chitinized plates, each with from twelve to fifteen teeth.

Pupa.— No cephalic crest. Pronotal breathing horns flattened, earlike, as broad as, or broader than, long. Mesonotum unarmed. Abdomen with transverse welts of fine hooks on basal annuli of tergites 3 to 7 and sternites 5 to 7. Two tiny spiracles on dorsum of eighth abdominal segment.

Limnobia is a rather small genus (comprising about forty-five species) of usually large and handsome flies. The species are most numerous throuout the Holarctic and Ethiopian regions. The immature stages have a wide range of habitat.

Of the European species, *Limnobia bifasciata* Schr. [= *L. xanthoptera* Meig.] is characteristically fungicolous, the larvae occurring in various species of Agaricus and related genera as stated by Stannius, Pastejrík, De Meijere, and other investigators. *L. decemmaculata* Lw. occurs in fungi (Daedalea and similar species), as recorded by Loew (1873) and by Verrall (1912). *L. quadrimaculata* (Linn.) [= *L. annulus* Meig.] often occurs in tree fungi but is not confined to this habitat. This species,

L. macrostigma Schum., and *L. obscuricornis* Bel. are often found in decaying, principally deciduous, wood. *L. tripunctata* Fabr., *L. sexpunctata* Fabr. [= *L. nigropunctata* Schum.], *L. flavipes* Fabr., and *L. nubeculosa* Meig. are found in humous earth and beneath leaves in woods. The pupal duration of *L. quadrimaculata* is from eight to twelve days, and this species, as well as others of the genus, pupates in the ground, inclosed in delicate silken cases which are covered with particles of earth and other matter.

In America, *L. triocellata* O. S. is characteristically fungicolous. *L. cinctipes* Say, and presumably *L. immatura* O. S., are found both in fungi and in decaying wood. *L. indigena* O. S. has been found in living tulip roots from Greenville, South Carolina (Greene, ms.). *L. fallax* Johns. and presumably *L. solitaria* O. S., live in organic mud near water. *L. parietina* O. S. probably has a similar habitat, since it was found in tent traps set over Beaver Meadow Brook in the Adirondacks (Needham 1908a:171).

Limnobia cinctipes Say

1823 *Limnobia cinctipes* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 21, no. 4.

Limnobia cinctipes is one of the largest and commonest American species of the genus Limnobia. It has been reared many times, some of the records being as follows:

On July 23, 1883, Pergande collected larvae in an old fungus growing on rotten wood. On July 20, 1886, the same species of larvae was found constructing silken cases thru the fungus, and later in the ground for pupation. The pupae were active, and were able to draw back and forth in their tubes. Adults began to issue on July 28, showing the pupal stage in this case to be not more than eight days.

On April 25, 1912, a number of specimens of this species were received from W. H. Shideler, of Miami University, Ohio. The specimens were taken at Oxford, Ohio, on April 20, when several hundred larvae and pupae were found in an old dry log. The young pupae in the wood are not covered with particles of débris, but the older pupae are inclosed in a case which is covered with wood fragments, only the top of the head and the tip of the abdomen projecting beyond the case. When the pupae are about to transform, the insect emerges to about half its length and the

kin splits down the dorsum, the pupal skin remaining in place after the dults have emerged.

On September 15, 1912, many full-grown larvae were found in a fleshy pecies of Fomes near Gloversville, New York, where they were asso- ated with a much larger number of larvae of *Ula elegans* and a much sser number of *Limnobia triocellata*. When about to pupate, the larva ecomes pale green in color and incases itself completely in a silken sheath hich is covered with particles of sand and other débris. As the pupa rows older, the case becomes harder and more rigid. Numerous little ites are to be found running up and down over these pupae, more pecially at the head end, and possibly seeking ingress into the insect. ne young pupa had a piece of cloth adhering to the side of its case. The upal stage lasts about five days.

Larva.— Length, 18–22 mm.
Diameter, 2.5–3.2 mm.

Coloration light yellow to greenish, the setiferous transverse welts at base of abdominal gments brownish.

Body terete, abdominal segments subdivided into two narrow basal rings and a broad sterior ring. Abdominal segments 1 to 7 with a broad basal welt on tergites and sternites, at of the first segment much smaller; these welts densely covered with microscopic hooks; the last two thoracic segments, welts indicated by very narrow lines. Cauda blunt, liquely truncated. Spiracular disk (Plate XXIV, 83, and Plate XXV, 93) surrounded indistinct lobes, the ventral margin projecting far caudad and indistinctly divided into o short lobes; lateral lobes very blunt; dorsal lobes short and blunt, often divided into o smaller lobes. Spiracles oblong or elliptical, placed obliquely. Gills four, blunt and nded, formed for propulsion rather than for respiration.

Head capsule (Plate XXIV, 79) very much as in Antocha, the dorsal plate narrowed behind d somewhat bifid at apex; lateral plates shaped like a mussel shell, curved around to form ntum. Labrum (Plate XXV, 86) distinct, oval, the anterior margin fringed with delicate irs, the hairs at the lateral margins longer and coarser; on either side near anterior margin, blunt tubercle with three sensory bristles; just laterad of this a stout seta; along anterior rgin, four sensory setae which are subequally spaced. Epipharynx densely hairy. ypeus broader than labrum, with a seta at each outer anterior angle and two more on her side near posterior margin. Mentum (Plate XXIV, 81) elongate-triangular, not com- tely divided into halves but deeply split behind, with an outer plate running cephalad into ong, broad point; behind this another plate with the margins toothed, there being about e or six long, acute teeth on either side. Hypopharynx (Plate XXIV, 80) with two ws of teeth forming a circlet, into which duct of salivary gland opens; anterior row having out nine large, blunt teeth, with about six smaller teeth on either side, these latter sharper- nted and more crowded; posterior row having long, pointed teeth, about twelve in nber. Antenna (Plate XXIV, 82) two-segmented, the basal segment chitinized, elongate-

cylindrical, the second segment flattened, shaped somewhat like a door knob; a few senso projections. Mandible (Plate XXV, 87 and 88) powerful, produced into a strong apic point, with about four or five blunt or irregular inner teeth and a strong dorsal tooth outer margin before tip. Maxilla (Plate XXV, 87) large, the outer margin thickened, su chitinized; palpi at apex small, shaped like half a pill box, with a few sensory papili at tip.

Pupa.— Length, 18–20 mm.
Width, d.–s., 2.8–3 mm.
Depth, d.–v., 3.1–3.3 mm.

Entire head and thorax, including leg and wing sheaths, light brown, the thoracic dorsu somewhat darker-colored, the wings more yellowish brown; abdomen pale light green, t segments with the submedian brown band interrupted on pleural region; tip of abdom brownish, chitinized.

Form stout (Plate XXV, 89); body destitute of noticeable setae.

Head flattened (Plate XXIV, 84). Cephalic crest lacking; forehead with a shallow V-shap notch between antennal bases. Eyes of male large, the front narrowed, with points tentorium close to inner margin of eye; eyes of female more widely separated. Antenn rather short, ending just beyond wing root. Labrum short, obtuse. Labial lobes contig ous, divergent, blunt at their tips, posterior margin a little convex medially. Lobes maxillary palpi large, subquadrate. Cheek with a large, flattened ledge overlying joint fore legs.

Thorax very gibbous. A distinct anterior median carina between breathing horn Pronotal breathing horns (Plate XXV, 90) flattened, earlike, broader than long, direct slightly proximad, margin with a row of breathing tubercles, outer face wrinkled. Wi sheaths reaching base of third abdominal segment. Leg sheaths reaching base of four abdominal segment or a little longer; tarsi ending about on a level, or sloping gradually fro short hind tarsi to long fore tarsi.

Abdominal segments indistinctly subdivided into three rings; on tergites 3 to 7, a sternites 5 to 7, basal ring with a transverse welt which is densely covered with short ha or hooks, these welts tapering gradually to ends; sternites of segments 3 and 4 having incon plete welts on either side of leg sheaths; band on tergum of segment 7 not broken mediall but a little constricted in some specimens; in older pupae the other annuli, especially t posterior one, variously darkened on dorsum and venter. Female cauda (Plate XXIV, 8 with the acidothecae short, the sternal valves the shortest, the tergal valves a little longe prominent lateral lobes at base of tergal valves, and a slightly smaller but very broad o on each side of tergal valves at about midlength. Male cauda (Plate XXV, 91) similar that of female, but the dorsal lobes (Plate XXV, 92) much shorter, not longer than the ve tral lobes, and separated by a U-shaped notch; ventral lobes approximated, each endi in a small, blunt tubercle. Two small circular spiracles on dorsum of segment 8, these little more widely separated in male than in female.

Nepionotype.— Gloversville, New York, October 26, 1912.
Neanotype.— Female pupa with type larva.
Paratypes.— Several larvae and pupae with types and from Oxford, Ohio, April 2 1912.

mnobia fallax Johns.

1909 *Limnobia fallax* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 125.

Limnobia fallax belongs to the *solitaria* group and is apparently more ıstral in its distribution than the other members of this group (*L. soli-ria* O. S., *L. hudsonica* O. S.).

Larvae and pupae were found by Dr. Johannsen near Ithaca, New York, ly 20–26, 1905. They were wrapped in silken cases covered with earthy ıtter, and were removed from the soil near a brook.

arva.— Length, contracted, 8–8.2 mm.
Diameter, 1.2–1.3 mm.

oloration white.

orm stout and short, body terete. Transverse welts with chitinized points on abdominal nents 2 to 7, those on dorsal surface broad, those on ventral surface narrower. Spiracular blunt, surrounded by four indistinct lobes, the lateral pair the largest and capable of e approximation, closing the large yellow spiracles. Anal gills indistinct.

ead capsule of usual Limnobia type. Labrum (Plate XXVI, 95) broadly oval, lateral les and disk of epipharynx with tufts of long hairs; anterior margin fringed with short e; about eight sensory bristles and papillae along anterior margin. Mentum (Plate VI, 96) large, triangular, running out into a long median apical point; lateral margins about six or seven flattened subacute teeth on each side. Hypopharynx as in this group: llar formed of two chitinized, comblike plates; the first plate rectangular, its face covered flattened scales, anterior margin with about fourteen acute pointed teeth, the two rmost much the smaller, acicular; the second plate a narrow band of chitin similarly hed, the teeth at each end large, flattened, the next tooth very narrow, acicular, the aining teeth, ten in number, flattened, acute, the middle teeth a little shorter and broader. enna (Plate XXVI, 97) with basal segment elongate, cylindrical, and apical papilla or seg-t very tiny, disklike. Mandible (Plate XXVI, 98) large, moderately broad, with apical h prominent, two large dorsal teeth, and a row of about five or six comblike teeth along ral cutting edge, the most basal being short and blunt. Maxilla (Plate XXVI, 99) ıt as in this tribe, cardines and stipites large and simple; palpus large.

upa.— Length of cast pupal skin, 10–13 mm.

abrum (Plate XXVI, 100) triangular, apex obtuse. Labial lobes prominent, subquadrate. erior margin convex medially. Pronotal breathing horns (Plate XXVI, 101) flattened, ircular in outline, with an outer marginal row of breathing tubercles. Leg sheaths ng just before apex of fourth abdominal segment; tips of tarsi about on a level, or those ore legs a little the longer. Band of spicules on seventh tergite, slightly constricted ially. Female cauda (Plate XXVI, 102 and 103) with tergal valves a little longer than al valves, and more acute at their tips; a small tubercle on outer margin of outer lobes re tips.

epionotype.— Ithaca, New York, July 21, 1905.
eanotype.— Cast pupal skin with type larva.
ratypes.— One larva and three pupal skins.

Limnobia triocellata O. S.

1859 *Limnobia triocellata* O. S. Proc. Acad. Nat. Sci. Phila., p. 216.

Limnobia triocellata is a common crane-fly in eastern North Americ It is closely allied to the European *L. bifasciata* Schr., the immature stag of which have long been known.

Johnson (1906:2) found larvae of this species in a fungus at Riversid Massachusetts, on August 21, 1904, which pupated on the 22d and emerg on the 30th and 31st, thus giving a pupal duration of about nine da Malloch (1915–17 b:215–216) found larvae and cast pupal skins in an Aga cus at Urbana, Illinois, in September of 1915. The writer found larv of *Limnobia triocellata* in a species of Fomes, associated with the larv of *L. cinctipes* and *Ula elegans*, at Gloversville, New York, on Septemb 15, 1912. C. H. Popenoe found larvae at Great Falls, Virginia, on Se tember 8, 1912, in the fungi *Hypomyces Lactifluorum* (Schw.) Tul. a *Armillaria* sp., the adult flies emerging on October 7, 1912. Other spec mens from the same place found on October 9, 1913, in a species of Clit cybe, produced adults on October 20. Scores of specimens were taken *Boletus felleus* at Bradley Hill, Maryland, the flies emerging on Ju 16, 1914.

Larva.— Length, 10–18 mm.
Diameter, 1.2–1.4 mm.

Coloration a little more yellowish than that of *Limnobia fallax*. Species very close *fallax* in all details. Ventral welt on abdominal segment 1 well developed, but dorsal w lacking or very reduced. Spiracular disk (Plate XXVI, 94) rather large, exposed; circu spiracles large, separated by a distance less than the diameter of one; lobes surroundi disk small and indistinct.

Pupa.— Length, 12–15 mm. Not very different from other species of genus describ herein.

Nepionotype.— Great Falls, Virginia, September 28, 1913.
Paratypes.— With the type.

Genus **Libnotes** Westwood (derivation obscure)

1876 *Libnotes* Westw. Trans. Ent. Soc. Lond., p. 505.

Libnotes is a small genus (about thirty-five species) of rather lar crane-flies, which are chiefly Oriental in their distribution altho thr species occur in South and Central Africa. The species *Libnotes pe kinsi* (Grimsh.) has been considered as being a Limnobia, but it seem

the writer that the present generic reference is more nearly correct, ho the distinctions between Limnobia and some species of Libnotes e very poorly marked. *L. perkinsi* was bred from larvae in damp moss erkins, 1913: clxxxii, as Limnobia), and in a letter to the writer Mr. O. H. ezey states that he has reared this species from larvae in decaying getation and in the accumulation of débris behind old leaf-sheaths on nana plants (Musa, Scitamineae) in the Hawaiian Islands.

nus **Discobola** Osten Sacken (Gr. *discus* + *I throw*)

1865 *Discobola* O. S. Proc. Ent. Soc. Phila., p. 226.
1869 *Trochobola* O. S. Mon. Dipt. N. Amer., part 4, p. 98.

Discobola is a well-marked genus including about eight described ecies, which are most numerous in the Australasian region, two species ly being found in Europe and two others in America. The adults of e commoner American species, *D. argus* (Say), are not rare. They are ost numerous in late summer, and are often found resting on the stumps d trunks of coniferous trees, especially white pine (*Pinus Strobus* nn.).

The immature stages of *D. caesarea* (O. S.) were found by Mik (1884) Austria, living in decaying pine stumps from which the bark had been moved. The following account is taken entirely from Mik's paper:

Male pupa.— Body cylindrical, slender (9.2 mm. long, 1.5 mm. in diameter). Head, thorax, mesothorax, leg sheaths, and wing sheaths chitinized, dark brown, shiny, the -named somewhat brighter than the others, the leg sheaths somewhat darker at their s. Eyes kidney-shaped, strongly shiny, blackish, between them a small, triangular, ckish brown spot. Prothoracic breathing horns dull-colored, dark rust-brown at base, oming a brighter rust-brown more distally, compressed laterally, tuberculate, with margin ented. Prothorax carinate, rust-yellow, margined on both sides by dull reddish brown ercles. In fully colored specimens, forehead and leg sheaths blackish brown, wing pat- n indicated on sheaths as somewhat diffused rings. Leg sheaths reaching end of abdominal ment 3, wing sheaths reaching end of abdominal segment 1. Metathorax and abdomen n-skinned, the former verdigris-colored, the latter white or somewhat yellowish green; tathorax resembling an abdominal segment, but its posterior margin is unarmed, while first to the fifth abdominal segments on both dorsum and venter bear a comb of very small, rt, blunt teeth, which are closely approximated; these teeth chitinized and rusty brown at ir tips, giving to abdomen the appearance of having brown incisions; these transverse s of teeth interrupted at pleura. Sixth abdominal segment pale thruout and lacking comb. Seventh segment shorter and narrowed on dorsum, pale, bearing on sternum ust-yellow chitinized plate which is narrowed anteriorly, leaving an uncolored triangular on either side at base of segment. Eighth segment swollen to include genitalia, the

two basal parts ellipsoidal, strongly shiny, rust-yellow, somewhat darker at tips, the apica parts small and knotlike, bluntly rounded; segment bearing on dorsum a weak triangula piece at its base; between apical parts of genitalia are inserted two small chitinized shields on venter, between basal parts, sheath of penis is inserted.

Female pupa.— Body resembling that of male, but longer and somewhat stouter (lengt 10.5 mm., diameter 1.8 mm). Leg sheaths extending to just beyond midlength of abdomin segment 2. Seventh abdominal segment shortened and somewhat narrowed, on dorsu largely pale, with a narrow chitinized margin only on lateral parts, so that the unchitiniz part forms a triangle with the apex directed backward; on sternum this segment almo completely chitinized, rust-yellow, only a small triangular area at base on either side remai ing uncolored; chitinized plate separated from plate of next segment only by an incomple segmentation, swollen, and bearing two longitudinal impressions. Eighth segment bearin on its dorsal surface the dorsal valves of ovipositor, fused at their base, chitinized thruou rust-yellow in color; segment bearing on its ventral surface a depressed conical chitiniz plate of a rust-yellow color, and with transverse impressed wrinkles; on either side a smal dark, chitinized, lower valve of ovipositor. Other characters as in male. (When the pupa are placed in alcohol, the green of the metathorax and the abdomen disappears and replaced by a yellowish white color.)

Pupae were collected in large numbers in a pine wood near Hammer in Freistadt (upper Austria) in the latter days of August, 1882. Th pupae live in pine stumps, near the ground, where the bark has bee removed, more especially in situations where the wood is somewhat sapp and not yet completely decayed. Those found were not deep in the woo Their presence was discovered by finding the teneral adults on and nea a stump, and many cast skins of the pupae projecting horizontally, th caudal end of the body, up to the leg sheaths, adhering to the wood. N emergence holes were found on the cut surface of the stump. The adult at first have a very long, pale abdomen, which is of a verdigris colo most intensive at the base and paler toward the tip. The pupae tha were found transformed as adults in from one to three days.

Genus **Geranomyia** Haliday (Gr. *crane* + *fly*)

1833 *Geranomyia* Hal. Ent. Mag., vol. 1, p. 154.
1835 *Limnobiorhynchus* Westw. Ann. Soc. Ent. France, vol. 4, p. 683 (spurious name
1838 *Aporosa* Macq. Dipt. Exot., vol. 1, part 1, p. 62.
1865 *Plettusa* Phil. Verh. Zool.-Bot. Ges. Wien, vol. 15, p. 597.

Geranomyia is a rather extensive genus including about eighty specie which are most abundant in the tropics of America, Asia, and Australi On the African continent the genus is apparently less common. Th adult flies have an elongate rostrum which is used for sucking nect

m tubular flowers. The various species of the genus have been recorded feeding on a wide range of plant species, which have been indicated by ab (1910) and by Alexander (1916 b:486–493) and may be summarized follows:

Species	Plants frequented
nomyia canadensis	Compositae — Eupatorium, Solidago, Aster, Silphium, Rudbeckia, Verbesina, Cacalia, and similar species
nomyia diversa	Compositae — Solidago, Erigeron Umbelliferae — Daucus
nomyia virescens	Lauraceae — Persea
nomyia rostrata	Compositae — Eupatorium, Solidago, Helianthus

For many years nothing was known concerning the immature stages any species of Geranomyia. In 1917, J. R. Malloch found larvae and pae of *G. canadensis* at Urbana, Illinois. Mr. Malloch and the writer re in press a detailed paper on the immature stages of this species, and following brief account is abstracted from this paper and included ewith in order to complete the data.

Mr. Malloch found the larvae on the grounds of the Floriculture Department of the University of Illinois. There is a small bubbling fountain e, the waste water from which flows along an open gutter. In this ter the immature stages of *G. canadensis* lived among the vegetable wth and diatomaceous ooze in the bottom of the trough. Mr. Malloch l the writer found this same species in Union County, southern nois, in 1919. Here larvae and pupae occurred on the face of rocks ere the surface was continually damp with percolating water. A road bank had been formed by piling up slabs of limestone to a height about four feet. In the irregularities and crevices of these pieces limestone, the larvae of Geranomyia were living in delicate silken es covered with a deposit of silt and diatoms. They emerged from r cases to feed on the exposed surface of the wet rocks during twilight, even during the hours of sunlight, but upon being disturbed or alarmed y retreated with great agility into their tubes. The pupae are found short, nearly vertical burrows in the same situations as the larvae; they rest with only the long, conspicuous breathing horns projecting n the entrance to the burrow. When transformation takes place, pupal skin projects from the mouth of the burrow nearly to the ends

of the wing sheaths. The number of larvae vastly exceeds the numb of pupae, and this would seem to indicate that the pupal existence is very short duration, else this stage would be found oftener.

Larva.— Length, 12–12.5 mm.
Diameter, 0.8–0.9 mm.

Coloration grayish subhyaline; a large orange area on posterior lateral parts of prothor abdominal welts dark brown.

Form moderately long and slender; thoracic segments gradually decreasing in length fr prothorax to mesothorax; abdominal segments gradually elongated to the fifth, thence sh ened to end of abdomen. Ventral surface of meso- and metathorax and of first eight abd inal segments provided with a basal transverse welt which is densely set with microsc points; on dorsal surface these bands smaller, occurring on metathorax and on abdomi segments 2 to 8, not connected with sternal bands except on metathorax and on eig abdominal segment. Spiracular disk similar to that in Dicranomyia; the usual ven lobes represented only by two small, dusky, setiferous areas. Spiracles large, elong oval, placed obliquely on the sides of a deep split and so capable of close approximati Anal gills four, each short, tapering gradually to the blunt tip.

Head capsule compact, massive, as in tribe. Labrum transversely oval, margin with sh yellowish hairs and a larger tuft on either side. Antenna two-segmented, second segm rather stout, cylindrical, slightly arcuate; apical papilla small but high. Mandible broad flattened, with a small dorsal tooth and a row of five ventral teeth. Maxilla generalized structure, as in tribe. Hypopharynx as in Limnobaria, consisting of a roughly circ chitinized collar provided with a crown of stout teeth. Mentum broad, undivided, ante margin with eleven teeth.

Pupa.— Length (including breathing horns), 8–9 mm.
Length of breathing horns, 1.2–1.3 mm.
Width of body, d.-s., 0.85–0.9 mm.
Depth, d.-s., 1–1.05 mm.

Pronotal breathing horns grayish subhyaline; head and thorax with sheaths dark bro abdomen whitish, hooks and spines brown.

Cephalic crest small, indistinctly bilobed, not setiferous; front long and parallel; ros sheath very long and narrow, subtended on either side by sheaths of paraglossae, the la projecting beyond tip of rostrum and ending almost opposite end of wing sheath; ma of cheeks flattened as in Limnobaria. Antennal sheaths short, ending slightly beyond b of wing pad. Pronotal breathing horns very large and prominent, not contiguous basa about a dozen breathing pores along dorsal margin. Mesonotum unarmed; wing shea ending opposite base of third abdominal segment; leg sheaths ending opposite or sligh beyond midlength of fourth abdominal segment; tarsal sheaths ending about on a le Abdominal segments 3 to 7 near base with two bands of chitinized hooks arranged in cur transverse rows inclosing an oval transverse area. Cauda chitinized, tergal region produ into two parallel curved hooks bending strongly dorsad.

Found at Alto Pass, Union County, Illinois, June 6, 1919.

enus **Dicranomyia** Stephens (Gr. *fork* + *fly*)

1818 *Furcomyia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 106 (*nomen nudum*).
1829 *Dicranomyia* Steph. Cat. Brit. Ins., vol. 2, p. 243.
1830 *Siagona* Meig. Syst. Beschr. Zweifl. Ins., vol. 6, pl. 65, figs. 5–7.
1830 *Glochina* Meig. Syst. Beschr. Zweifl. Ins., vol. 6, p. 280.
1854 *Numantia* Bigot. Ann. Soc. Ent. France, ser. 3, vol. 2, p. 470.

Larva.— Form slender. Body nearly glabrous, abdominal and thoracic segments with sal and ventral transverse welts on basal annuli. Spiracular disk small, the five lobes istinct but indicated, spiracles large. Anal gills four, slender. Head capsule massive, he Limnobia type. Mouth parts almost as in Limnobia; ventral cutting edge of man-le with fewer teeth; mentum with anterior margin more transverse and with fewer h.

Pupa.— Cephalic crest lacking. Pronotal breathing horns broad, in *D. simulans* with asal recurved hook on dorsal side, in other known species unarmed. Basal abdominal uli with transverse welts. Dorsum of eighth abdominal segment with vestigial spiracles.

Dicranomyia is a very extensive genus including more than two hun-ed described species of usually small flies which are found in most parts the world. The immature stages, which are found in a variety of bitats practically as extensive as is covered by the entire family of ane-flies, range from forms that are almost strictly aquatic, thru species ing beneath the bark of trees, to still other species which are leaf miners. In Europe, *Dicranomyia trinotata* (Meig.) is a characteristic member the hygropetric association, the insects living on rocks in streams, ere they are covered with a thin sheet of water and are usually asso-ted with such insect forms as Beraea, Tinodes, Stactobia (Trichoptera), *ohnephila testacea* (Ruthe), *Pericoma nubila* (Meig.), *Dixa maculata* eig., *Oxycera pulchella* Meig., and other Diptera. The larva is cylin-cal, measuring from 10 to 11 millimeters in length and from 1.5 to millimeters in diameter. The dorsal surface is greenish mottled with rker, the ventral surface brighter. The larvae live in loosely spun ken cases in which they pupate. The pupae are about 10 millimeters g, and live in cocoons which are almost horizontal in position. The ture pupa breaks thru the cocoon by means of its sharp-edged breathing rns, the adult then creeping forth and leaving the cast pupal hull behind. hienemann, 1909:64–65, and Grünberg, 1910:29.)

Dicranomyia dumetorum Meig. lives in decaying, principally deciduous, od. Winnertz (1853) found it in large numbers in a decaying beech e, associated with *Bremia cilipes* (Winn.).

A species of crane-fly doubtfully referred to *Dicranomyia pilipenn* Egg. (Schubart, 1854) has been found in ditch water in Holland.

Dicranomyia umbrata de Meij., a Javan species, lives in the slimy gre algae floating in stagnant, as well as flowing, water. The pupae live cocoons in the algal sheath, with the cephalic end projecting. The larv are from 10 to 12 millimeters in length, cylindrical, about 0.6 millimet in diameter, and of a yellowish color. The head is almost entire retractile. The body is almost smooth, having only an inconspicuo transverse welt on the second abdominal segment near the poster margin. The caudal end is somewhat enlarged and is truncated behin De Meijere (1916:197–198) supplies a good description of the structu of the larval head capsule.

Dicranomyia foliocuniculator Swez., of the Hawaiian Islands, is t only recorded leaf-mining crane–fly. It was found by Swezey mini in the leaves of a species of Cyrtandra (Gesneriaceae) in the island Oahu. Pupation of the species takes place within the mines (Sweze 1913 and 1915).

In North America a number of species are known. *Dicranomy simulans* has been ably discussed by Needham (1908a:214–217) and lat by Malloch (1915–17b [1917]). This species is, for the most part, member of the hygropetric fauna, dwelling in usually lotic water whe it is associated with a characteristic rapid-stream fauna. Other co ditions under which the species is found are discussed later. *D. bad* and *D. stulta* live in and under saturated moss cushions. *D. macat* Alex. has been bred from larvae in decaying wood (Dr. W. G. Diet *D. rara* O. S. has been bred from larvae in a rotten willow, the larv being taken on Plummers Island, Maryland, by H. S. Barber on Oct ber 12, 1913, and emerging as adults on November 14.

Dicranomyia simulans (Walk.)

1848 *Limnobia simulans* Walk. List Dipt. Brit. Mus., vol. 1, p. 45.

The best account of the life history of the common and widespre *Dicranomyia simulans* is that by Needham (1908a:214–216), quot below:

> It is abundant on the piers along the west shore of Lake Michigan. . . . This p [at Lake Forest, Illinois] was built on heavy driven piling, covered outside with heavy pla About three feet of surface was exposed above the water at its normal stage. The pla were old, and sheltered a scanty growth of short, stemmed mosses in the cracks, and b

eavy fringe of Cladophora and other algae just below the water line, with a film of "skin ae" extending a little higher.

All over the sides of the plank, in either sun or shade, the adult *simulans* could be seen oughout the summer months, sometimes in considerable numbers. I was first attracted notice them by their habit of running rapidly sidewise along the pier, and their resemblance harvestmen (Phalangidae). They run habitually sidewise, apparently rarely moving ward except to escape an obstruction, and very rarely appearing on the top of the pier. ey rest in an inverted position on the under surface of the overhanging plank on the top the pier. They stick to the surface so persistently that it is difficult to make one take ht; they may be driven all about on the surface, or poked with a stick; they can fly well ough when they will, but when induced to fly they settle again almost at once, and within ew feet of their starting place.

They are associated upon the piers with *Geranomyia canadensis* and with numerous dges and micro-caddis flies (Hydroptilidae) and a few larger caddis flies of the genus dropsyche.

Males are more in evidence, but probably not more abundant in fact. The females come from their resting places only to lay their eggs, and are only to be seen when busily engaged the performance of this task. They stand on tiptoe, with the long ovipositor held in tical position at the tip of the deflexed abdomen, and they swing the body up and down rapid shuttlelike vibration, freely rising and falling on the long and widely outspread s. Thus the point of the ovipositor is driven against the wet surface of the plank, thrusting ost as rapidly as the needlebar of a sewing machine; it is moved about over the surface, if searching for soft spots in the wood, and occasionally it makes a deeper thrust when a table place is found, and an egg is deposited.

The egg-laying process is often interrupted and is continuously interfered with by the importunate males. When a male in running about on the plank comes upon a female positing, he stands directly above her at the full upward stretch of his legs, while she s right along with her work; but the instant she ceases her vibrating and lifts her ovi-itor, he is ready with his forceps, upturned and outspread at the tip of his decurved abdo-n, to seize her. Usually she does not want to be interrupted and moves away, while he s to run parallel and maintain all the while his position of vantage above her. Often er males are encountered, and then the males engage in a rough and tumble fight. They sh and shove each other in a most ludicrous manner, reminding one of pigs fighting, l often an encounter of this sort enables the female to escape and go on quietly with work.

The males have well developed eyes, but their sight must be very poor; for, while always rching for females, they seem quite unable to find them by sight, often passing females work within a distance of a few centimeters. But their tactile sense seems more acute. en a male in running to and fro had passed several times within six centimeters of a ale without noticing her, was deflected from his course toward her by an obstruction urposely placed in his way, he instantly sprang toward her upon the slightest contact, n of tips of tarsi, but was quite unheeding until this contact occurred. If it did not occur would pass on, even by the narrowest margin.

All stages are found together on the piers. The eggs are laid in the soft spots in the old od, where the surface of the pier is kept wet, but not continually covered by water, in zone of the "skin algae." The larvae live exposed or thinly algae covered, and crawl ut slowly over the wet surface. They are greenish in color and very inconspicuous. a cavity among the stems of the dwarf mosses (*Bryum binum* Schoeb. var. *varium* Lindb. *Amblystegium orthocladon* Lesq. and James) in a crevice at the upper limit of the area the larva spins about itself a sheet of tissue and fastens bits of moss stems and ves to its outside, and transforms inside the tube thus formed into a pupa. The tube onger than its body, and the pupa moves in or out at will, doubtless by the aid of the ks at the ends of its body.

The following descriptions of the immature stages are adapted fro those of Needham and Malloch:

Larva.— Length, 10–15 mm.
Diameter, 1.5–2 mm.

Coloration green, with distinct brown marks on dorsum and with an interrupted mi dorsal row of alternating paler dots and crossmarks; dark area made up of closely pla spinous hairs, clear areas for the most part devoid of hairs.

Body cylindrical, abruptly tapering behind on last abdominal segment. Legs lacking, b a scurfy, pubescent creeping-fold on under surface of meso- and metathorax, a similar onc first abdominal segment, and much larger, transversely placed, fusiform creeping-ridges ventral surface of abdominal segments 2 to 7, on anterior ring of each segment. Incisio between dorsal segments of abdomen margined with blackish spinules, which are slight stronger than other hairs of dorsum. Spiracular disk vertically cleft, with sloping sid folded together when under water, border of aperture fringed with short hairs and destitu of fleshy lobes. Spiracles oval. Anal gills four, fleshy.

Head large, similar in general appearance to that of Limnobia, entirely retractile with enlarged prothorax; head showing a broad, pale yellow, median band, sides black from ba of antennae backward. Labrum transversely oval, with a margin of close-set, scurfy hair clypeus one-fourth broader than labrum, yellow, with parallel sides but emarginate on fro for reception of labrum; three recurved, stout setae on lateral margin of clypeus on each si one on each angle and two on disk. Mentum slightly convex in outline, median tooth mu longer and stouter than first lateral, second and third laterals as large as median toot Antenna long, the shaft about three times as long as its greatest diameter. Maxillary pal short and inconspicuous.

Pupa.— Length, 8–9 mm.
Diameter, 1.5 mm.

Body smooth and shiny, ends brownish. Front of thorax upcurved dorsally. Pronot breathing horns broad, laterally flattened, obtuse at apex, each with a basal recurved, sha hook on its dorsal side; breathing tubercles arranged in a semicircular row along obtuse t of horns. Dorsum of thorax with a faint fretwork of raised lines on surface. Abdom smooth, with transverse lines of scurfy pubescence, terminating in a pair of stout, sharp recurved hooks.

Malloch (1915–17 b, pl. 33, fig. 5) has figured the peculiar pronot breathing horn of this species.

Dicranomyia stulta O. S.

1859 *Dicranomyia stulta* O. S. Proc. Acad. Nat. Sci. Phila., p. 210.

Adults of *Dicranomyia stulta* are often exceedingly abundant, flyi about, or resting in close proximity to, rocky ledges or cliffs near stream They are found commonly in June, associated with such crane-fly speci

Geranomyia canadensis, *Dactylolabis montana*, *Tipula ignobilis*, *T. api-*
s, and similar forms. The larvae live in and beneath the saturated
nions of moss (Amblystegium) that grow on the shale near the water's
e. The only associated crane-fly larvae found near Cascadilla Creek,
aca, New York, where this species is common, were *Tipula ignobilis*,
larvae of both species being exceedingly abundant.

rva.— Length, 10–12.2 mm.
Diameter, 0.6–0.7 mm.

olor pale whitish with a green cast; transverse abdominal welts dark brown.
rm rather long and slender. In addition to dorsal and ventral welts on abdominal
ents 2 to 8, a complete band at base of metathorax and ventral bands on mesothorax
first abdominal segment; ventral abdominal bands larger and more conspicuous than
w dorsal welts. A few erect setae on body. Spiracular disk (Plate XXVII, 105) rather
, with a deep vertical split, the large ovate spiracles capable of close approximation;
al lobes blunt, with a black spot on face, fringed with short black hairs and with two
ry setae; each blunt lateral lobe narrowly lined with a black crescent; dorsal lobes very
, dusky; spiracular disk fringed with short, dark hairs. Anal gills four, large and pale.
ad capsule as in tribe. Labrum (Plate XXVII, 106) subtriangular; anterior margin
d, nearly straight across, with a dense fringe of hairs which are coarser at ends of
near anterior margin of labrum two oval, hyaline areas, each with three short papil-
a few sensory setae along anterior margin. Mentum (Plate XXVII, 107) broad,
ior outline triangular, running out into a rather long apical point, each side with about
teeth. Hypopharynx (Plate XXVII, 108) as in this group of genera, consisting of a
of two chitinized combs, each with about ten sharp teeth. Antenna (Plate XXVII, 109)
, cylindrical, the apical papilla very small, reduced to a tiny disk. Mandible (Plate
II, 110) broad, flattened, with a blunt apical point which is only a little longer than
eeth on either side of it; ventral cutting edge with about five blunt teeth, which are
ually smaller from the outermost toward the base; inner face of mandible with a blunt
hecal tooth and an oblique fringe of coarse setae. Maxilla (Plate XXVII, 111) with
ardines large, with about three setiferous punctures; stipites short, cylindrical; outer lobe
ed with long hairs and bearing the short, flattened, disklike palpus, which has five or six
ne pegs; inner lobe smaller, with dense, short hairs and a few sensory organs.

pa.— Length, about 6 mm.
brum very obtusely rounded at apex, not bilobed. Labial lobes straight across or very
ly convex across posterior margin. Maxillary palpi narrowed toward tips (Plate
III, 112). Pronotal breathing horns (Plate XXVIII, 113 and 114) elongate-oval,
e, the ventral margin more bulging, the apex a little narrowed but obtuse; a row of
hing pores along outer margin, beginning on lateral face near dorsal margin, these few
mber and widely separated, becoming more numerous toward apex of organ. Leg
hs as usual in this group of genera, those of fore legs the longest, those of hind legs
hortest. Male cauda (Plate XXVIII, 115) with ventral lobes (Plate XXVIII, 116)
bluntly rounded at tips; two small, brown, approximated tubercles at base of split on

ventral side; two blunt tubercles on dorsal surface near base and close to median line (Pl XXVIII, 117). Tergal lobes at outer angles of a flattened plate, very short, triangular, ea with two small hairs on caudal face before tip.

Nepionotype.— Cascadilla Creek, Ithaca, New York, May 22, 1917.
Neanotype.— Type locality, June 6, 1917.
Paratypes.— Abundant larvae and pupae with types, May 22 to June 6, 1917.

Dicranomyia badia (Walk.)

1848 *Limnobia badia* Walk. List Dipt. Brit. Mus., vol. 1, p. 46.
1859 *Dicranomyia humidicola* O. S. Proc. Acad. Nat. Sci. Phila., p. 210.

Dicranomyia badia is a very common species thruout eastern Ne America, occurring in gorges and ravines and along streams. The ad flies may be found resting on perpendicular cliffs near these haunts. a position of rest they have all six feet on the support, a very differ resting position from that of the often-associated genera Oropeza a Dolichopeza.

The larvae, as is frequent in this genus, live in and beneath mo especially saturated cushions of moss growing in or near the margins streams. They are of a clear light pea-green color, and simulate the m to an astonishing degree. The writer found these larvae in Needhan Glen, Ithaca, New York, on April 16, 1917, beneath wet cushions *Amblystegium irriguum* (Hook. & Wils.) B. & S., a moss that cov all the rocks and stones near water. In these moss cushions the larv were associated with tiny larvae of *Tipula ignobilis* and pupae of *collaris*. When ready to pupate, the larva spins a small, silken, s covered case, which is further protected by a covering of small pieces moss stems adhering to its outside, this case being hung up in the m cushion, with the cephalic end of the pupa projecting. The pupal durati is about seven days (April 21 to 28 in the cases observed). The da colored pupa, with its contrasting yellow breathing horns, is ve handsome.

Larva.— Length, 10.5 mm.
Diameter, 0.6–0.65 mm.

Coloration light pea-green, abdominal welts brown; after death general color fading very pale greenish white.

Form slender; body terete, dorsal and ventral transverse welts at base of abdominal s ments conspicuous. Spiracular disk (Plate XXVII, 104) with lobes indistinct, suffused w dusky, lateral lobes very blunt; disk surrounded by a fringe of short, dark-colored ha Spiracles very large, ovate, dorsal ends close together. Anal gills long and slender, p

Head capsule and mouth parts similar to those of *D. stulta*, already described, judging from scanty material of *D. badia* available for study.

Pupa.— Length, 8–8.5 mm.
Width, d.-s., 1.1 mm.
Depth, d.-v., 1.2 mm.

Head, thorax, and appendages dark brown; pronotal breathing horns light yellow; abdomen enish, the cauda chitinized, light brown.

Labrum very broad, indistinctly bilobed at tip. Labial lobes large, broadly transverse, terior margin almost straight across. Maxillary palpi broad, tips truncated (Plate XXIX,). Lateral margins of cheeks flattened into ledges.

Pronotal breathing horns large, flattened, in lateral outline (Plate XXIX, 118) subcircular or rly so, with a row of rather widely separated breathing tubercles along margin; as viewed n above, horns directed proximad, so as to be contiguous at tips. A high median crest mesonotum behind breathing horns. Wing sheaths ending before apex of abdominal ment 2. Leg sheaths ending far before apex of abdominal segment 4; as usual in this sion, the hind legs a little the shortest, the fore legs a little the longest. Abdominal ments with a distinct basal welt which is thickly margined with microscopic curved hooks. eral spiracles distinct, but small and probably nonfunctional. Female cauda with sternal ves shorter than long tergal valves, the latter (Plate XXIX, 120) almost straight, each with owerful, acute spine on lateral margin at about midlength, this directed dorsad. Near the gin of segment 8, on dorsum, a pair of rudimentary spiracles.

Nepionotype.— Needham's Glen, Ithaca, New York, April 16, 1917. (No. 5–1917.)
Neanotype.— Type locality, May 7, 1917.

nus Rhipidia Meigen (Gr. *a fan*)

1818 *Rhipidia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 153.
1911 *Ceratostephanus* Brun. Rec. Indian Mus., vol. 6, p. 271.

Larva.— Form rather stout, body terete. Abdominal sternites 1 to 7 and tergites 2 to ith narrow transverse basal welts of chitinized points. Spiracular disk with indistinct s. Head capsule massive, not unlike that of Dicranomyia. Labrum broadly transverse. ndible very broad, flattened, with only three ventral cutting teeth. Maxilla of simple cture. Antenna with apical papilla or segment very flattened, disklike. Hypopharynx wo chitinized plates, each with about twelve comblike teeth. Mentum almost transverse ss anterior margin, with from nine to eleven teeth, the outermost fused.

Pupa.— Pronotal breathing horns elongate for this subtribe, about three times as long as d. Abdomen with transverse bands of spicules on tergites 3 to 7 and sternites 5 to 7, on extreme lateral parts of sternites 3 and 4.

Rhipidia is a small to medium-sized genus (about thirty-five species) ving its center of distribution in the American tropics, with some cies occurring thruout temperate Europe and America and a less number Africa and the Oriental region. The genus is based on a sexual char-

acter, the pectinate antennae of the male, and several of the spec run inconveniently close to Dicranomyia.

The immature stages are spent beneath the bark of decaying trees in decaying vegetable or animal matter. In Europe the genoty *Rhipidia maculata* Meig., has been recorded as living in old cow-manu Beling found the insects in such a situation, associated with the lar of *Rhyphus punctatus* (Fabr.) (Beling, 1879:52–53) and a staphyli beetle, *Platystethus morsitans* Payk. (Beling, 1873b:592). *R. uniseri* Schin. was found by Beling (1879:53–54) living in decaying beech wo in company with larvae of *Xylota lenta* Meig. and *X. segnis* (Linn.) (S phidae) as well as with larvae of a tipuline crane-fly, Ctenophora. T larvae of this species, like those of *R. maculata*, live in thin silken ca open at both ends and covered with particles of wood and other déb

In America, besides *Rhipidia bryanti* (which is discussed in some deta the following records of the immature stages are available: *Rhipi maculata*, recorded in Europe as living in decaying organic matter, w found by Needham (1908a:170, 204) in tent traps set over the bed Beaver Meadow Brook in the Adirondacks, the insects presumably ha ing emerged from the stream bed or from the thin layers of moss coveri the exposed stones. *R. fidelis* O. S. was reared from larvae in decaying wo near Ithaca, New York, by Carl Ilg. This species belongs to the sa subgenus (Monorhipidia Alex.) as the European *R. uniseriata*, which h similar larval habits. *R. domestica* O. S. has been bred from lar obtained in fermented sap of the sour gum (*Nyssa sylvatica* Mars Cornaceae) at Clementon, New Jersey (Johnson, 1910:704). Males a females of this species were bred by Popenoe at Washington, D. C from larvae on more or less decaying roots of taro (*Colocasia antiquor* Schott, Araceae) taken at Gough, South Carolina, on February 1, 19 Specimens of *R. domestica* emerged on August 21, 1906, at Junea Alaska, in radishes infested with *Hylemyia brassicae* (Bouché).

Rhipidia (*Rhipidia*) *bryanti* Johns.

1909 *Rhipidia bryanti* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 123–124, pl. fig. 20.

Rhipidia bryanti is one of the largest and handsomest species of t genus, and is widely distributed thruout the eastern United States fr Maine to Texas. The immature stages are spent beneath the decayi

ark of trees. The material studied was collected by J. R. Malloch in otomac Park, Washington, D. C., on May 11, 1913, and was reared y R. C. Shannon (No. 35–1913), whose notes on the subject are as follows:

A small colony (about seven) of tipulids were found in a hollow of a tree behind the bark. he larvae were covered with slime, which gathered débris as they moved about and so rmed a case. The next morning one had pupated. Two larvae were boiled and pre- rved in alcohol, while two others were preserved in formal. As they move about they ave a path of slime behind them. On May 14, the one that had pupated on the 12th nerged. On May 18 another imago issued.

There is an obvious error in the duration of the pupal stage as given — only two days. It is possible that a pupa was included in the material nd was overlooked in its case of débris. The date of emergence of the econd adult would show a pupal duration of six days, which is probably early correct.

Larva.— Length, 13.2–14 mm.
Diameter, 1 mm.

Coloration white.

Form terete, rather stout. Sternites 1 to 7 and tergites 2 to 7 with narrow transverse welts basal rings; welts yellow, provided with long, transverse rows of microscopic roughened oints, those along margins of welts coarser, those in centers very tiny; these rows inter- pted along pleura. Caudal end blunt, with lobes of spiracular disk indistinct. Spiracles rge, capable of close approximation.

Head capsule massive, of the Limnobia type. Labrum (Plate XXX, 121) broadly transverse, nterior margin almost straight across, near margin two oval areas which are provided with nall sensory papillae. Epipharyngeal region with abundant hairs. Mentum (Plate XXX, 22) chitinized, the anterior margin almost transverse, with a large median tooth and about ree lateral teeth on either side, the outermost of these an evident fusion of about three lesser eth. Hypopharynx (Plate XXX, 123 and 124) as usual in this subtribe, a collar-like structure mposed of two parallel combs united at the ends; the larger plate broadly elongate, surface ith abundant scalelike plates, anterior margin with twelve teeth, the lateral ones narrow, e teeth gradually enlarging toward the middle, the middle pair a little shorter; second plate hypopharynx broadly transverse, narrow, likewise with about twelve teeth, the two outer ost on each side long, subacute, the middle tooth shorter and more flattened; between the o middle teeth a small triangular or conical point. Antenna (Plate XXX, 125) short cylin- ical, the apical papilla a very flattened disk or button which is much broader than long. andible (Plate XXX, 126) very broad, flattened, with the apical tooth rather long and slen- r; two smaller teeth dorsad and three others ventrad, the dorsal teeth blunt, the ventral eth truncated, the most basal tooth very broad. Maxilla (Plate XXX, 127) of the simple neralized structure of this tribe; cardines large, with two setiferous punctures; stipites eakly chitinized basally; outer lobe of maxilla with the large flattened palpus at its tips; lpus surrounded by numerous long setae and having several hyaline sense pegs at its ex; inner lobe of maxilla smaller, with numerous long hairs, especially a slitlike brush ar margin.

Pupa.— Length, about 12 mm. (cast skin).

Labrum broad, rounded at apex. Labial lobes broadly transverse, caudal margin indistinctly trilobed. Maxillary palpi large, flattened, apex bluntly pointed; a rather angular tooth on margin near base (Plate XXXI, 128). Cheeks produced into flattened ledges. Antennae short and stout.

Pronotal breathing horns (Plate XXXI, 129) elongate for this subtribe, about three times as long as the greatest diameter, flattened, apical half slightly expanded, margin with tiny tubercles. Wing sheaths attaining base of abdominal segment 3. Leg sheaths attaining base of abdominal segment 5; tarsi ending about on a level, or hind tarsi a little the shorter and fore tarsi a little the longer. Abdomen with basal bands of setae on tergites 3 to 7 and sternites 5 to 7, and on the extreme lateral parts of sternites 3 and 4; these bands thickly margined with tiny, golden-yellow hairs or points, the median part of each band naked or nearly so. Male cauda (Plate XXXI, 130) with dorsal lobes (Plate XXXI, 131) very small, more or less flattened, divergent, rather blunt at tips; ventral lobes elongate, contiguous along inner face.

Nepionotype.— Potomac Park, D. C., May 11, 1913.
Neanotype.— Cast pupal skin, with type larva, May 14, 1913.
Paratype.— One larva with type.

Subtribe **Dicranoptycharia**

The subtribe Dicranoptycharia, so far as known, includes only the genus Dicranoptycha. The division is close to the Rhamphidaria but is easily separated from it in all stages.

Genus **Dicranoptycha** Osten Sacken (Gr. *fork* + *fold*)

1818 *Marginomyia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 147 (*nomen nudum*).
1859 *Dicranoptycha* O. S. Proc. Acad. Nat. Sci. Phila., p. 217.

Larva.— Form very elongate, terete. Integument smooth, glassy, transparent. Abdominal segments 2 to 8 each with a basal transverse band or area of microscopic chitinized points on ventral surface; segment 8 with a similar band on dorsum. Spiracular disk surrounded by four lobes, the lateral pair more slender than the blunt ventral pair; dorsal lobe very low or lacking; a triangular brown mark on disk between spiracles. Spiracles small, widely separated. Anal gills a fleshy protuberant ring surrounding anus.

Head capsule compact, massive, the prefrons large with a few marginal punctures; externo-lateral plates very broad. Labrum large, flattened, pale. Antenna two-segmented; apical segment almost as long as basal segment, gradually narrowed to the blunt tip. Mandible with a blunt dorsal and two blunt ventral teeth. Maxilla generalized in structure. Hypopharynx a rounded cushion. Mentum deeply split behind but not completely divided, with three principal teeth and a small reduced lateral tooth on either side.

Pupa.— Cephalic crest low, depressed, setiferous. Labrum tumid. Labial lobes oval, contiguous. Antennal sheaths ending opposite base of wing pad. Pronotal breathing horns microscopic, represented only by tiny triangular tubercles. Mesonotum unarmed.

ing sheaths ending opposite middle of third abdominal segment. Leg sheaths ending posite base of fifth abdominal segment, the tarsi terminating on a level or nearly so. bdominal tergites and sternites each with four transverse rows of microscopic setae; lateral iracles on segments 2 to 7; no apparent spiracles on dorsum of segment 8.

Dicranoptycha is a principally Holarctic genus including twelve known ecies, six of which occur in the United States. The flies are of medium ze and of a dull, inconspicuous appearance, and are rather difficult of xonomic separation. The life histories of members of this genus have ly recently been ascertained. The following notes are taken from ore detailed accounts in earlier papers by the writer (Alexander, 1919, and b).

The habits of the immature stages of Dicranoptycha may be briefly mmarized as follows: The larvae and the pupae live in rich humous il overlain with a cover of leaf mold and other vegetable débris. They equent open woods where there is more or less shubbery and tall herbage. unning streams or rills are not necessary for the development of the mature stages. The larvae live in the uppermost zone of the soil, where ey are associated with a rather characteristic group of animal forms, ch as dipterous larvae (Sciara), beetle larvae, and centipedes. They e characterized by the exceedingly long, slender body and the shiny abrous skin, and may be confused with no other dipterous larva yet ade known. The glassy appearance of the body suggests the shiny ell of a small univalve snail, the dead fragments of which occurred in me numbers in the same situations. The larvae of *Dicranoptycha innemana* Alex., an Austral species, attain a length of from 20 to 22 illimeters, with an average diameter of only 1 millimeter. The larvae the genus are herbivores. When ready to pupate they incase themlves in compact earthen cells, which are 10 x 3.5 millimeters in size, m in texture, and rather thick-walled but apparently without silk. here is a small opening at either end. The pupal period is about ten ys or possibly a little less. Pupation takes place in the relatively dry il that forms the larval haunt.

The pupa of *Dicranoptycha winnemana* measures from 9.1 to 12.8 illimeters in total length. The width at the wing pad is about 1.7 illimeters. The diagnostic features are given above at some length the genus and need not be repeated here. For other notes the reader referred to the papers already cited.

The adult flies of the various species of Dicranoptycha are usually abundant where they occur. They may be found resting on the upper surface of leaves of shrubbery and tall herbage in open woods, often far from water, which is not so necessary for development as with most species of Tipulidae.

Subtribe Rhamphidaria

The division Rhamphidaria includes the genus Rhamphidia, with the possible addition of a few exotic genera. Rhamphidia is one of the constituent genera of the former group Antochini, but differs considerably from all others whose life histories have been made known. The closest relatives of Rhamphidia seem to be the Dicranoptycharia, on the one hand, and the lowermost divisions of the Hexatomini, on the other. The larvae and the pupae of Rhamphidia present a curious eriopterine appearance, but their structure indicates only a distant relationship with the Eriopterini.

Genus Rhamphidia Meigen (Gr. *rostrum*)

1825 *Megarhina* St. Farg. et Serv. Encyclop. Method., Ins., vol. 10, part 2, p. 585.
1825 *Helius* St. Farg. et Serv. Encyclop. Method., Index, p. 831.
1829 *Leptorhina* Steph. Cat. Brit. Ins., vol. 2, p. 243.
1830 *Rhamphidia* Meig. Syst. Beschr. Zweifl. Ins., vol. 6, p. 281.

Larva.— Body terete. A transverse welt, covered with microscopic scabrous points, on ventral surface of basal annuli of abdominal segments 2 to 7. Spiracular disk surrounded by five short lobes which are fringed with abundant, rather long, hairs. Head capsule massive, generalized in structure. Mandible short and stout, ending in two subequal blunt teeth. Maxilla consisting of two rather short, densely hairy lobes. Antenna short. Hypopharynx chitinized, outer margin with about a dozen teeth. Mentum not completely divided, with five teeth. Coloration of body dark brown, produced by the dense appressed pubescence covering it.

Pupa.— Cephalic crest double, the anterior part low, the posterior part the larger; lobes setiferous, divergent. Two setae on front between eyes. Pronotal breathing horns long and slender, slightly curved. Mesonotum convex. Wing sheaths reaching end of second abdominal segment. Leg sheaths ending just before posterior margin of fourth abdominal segment; all the tarsi about equal in length, or those of fore legs a little longer. Abdominal segments with two narrow basal rings and a broader posterior ring having four narrow transverse bands of spicules and comparatively few setae. Spiracles rather large on pleurites 2 to 7, and a large conspicuous pair on dorsum of segment 8.

Rhamphidia is a small genus of crane-flies (about thirty-five species), widely distributed thruout the temperate and tropical regions of the world. The larvae of the European *R. longirostris* Meig. were found by Gercke

34) in submerged stems of the water dock, *Rumex aquaticus* Linn. eggs are described as being rather long, white, and granulate. It is gested that the developmental stages may be associated with water. two local species have been reared and are discussed herewith.

mphidia mainensis Alex.

1916 *Rhamphidia mainensis* Alex. Proc. Acad. Nat. Sci. Phila., p. 498–499, fig. 14.

hamphidia mainensis appears to be a rather uncommon form, much r than *R. flavipes*, the other local species. Adult flies were not ommon in the Basin Swamp, Orono, Maine, on June 12, 1913. This mp is a low, sunken area surrounded on most sides by hills, opening the "Basin," an affluent of the Penobscot River. Cold springs of er percolate down from these hillsides, and the soil is very wet, boggy, richly filled with organic matter. The chief floral constituents are w elms and white birches and an abundance of alders, *Spiraea latifolia* kh., and *S. tomentosa* Linn. The herbage consists of ferns such as clea and Osmunda, patches of Iris, *Impatiens biflora* Walt., and many es and sedges. Crane-flies associated with *R. mainensis* on the mentioned included the following: *Dicranomyia haeretica*, *phragma fascipennis*, *Pseudolimnophila luteipennis*, *P. inornata*, *nophila fasciolata*, *L. macrocera*, *Pilaria recondita*, *Ulomorpha pilosella*, *yphona inconstans*, *Erioptera vespertina*, and *Tipula sulphurea*, also bundance of *Ptychoptera rufocincta* and *Bittacomorpha clavipes*.

arvae were first found on April 20, 1917, in the dark, cold swamp wn as Larch Meadows, south of Ithaca, New York. Here they rred in the thick, black, saturated organic matter comprising the of the swamp. The vegetation consists of the dominant alder (*Alnus na* [Linn.] Moench.), the poison sumac (*Rhus Vernix* Linn.), and marsh marigold (*Caltha palustris* Linn.), as well as an abundance ther plant species in lesser numbers. The earthy material in which crane-fly larvae were found was full of the organic remains of plants, as ferns, leaves, alder catkins, and the like. Associated with these ae at this time were numerous small hydrophilid beetles, and a great ndance of larvae of a dascillid beetle of the subfamily Helodinae, arious sizes and ages. Numerous tabanid and stratiomyiid larvae, the larvae of the crane-fly species *Bittacomorpha clavipes*, *Pseudolimno- luteipennis*, and *Tipula dejecta*, also occurred.

The larvae were conspicuous by their dark coloration and, when plac in water, by their active, snakelike movements, in this regard being ve different from somewhat similar larvae of certain Eriopterini which th resemble superficially because of the five subequal lobes surrounding t spiracular disk. The indoor pupal period is six days (May 8 to 14, 191

Larva.— Length, 9–11.2 mm.
Diameter, 0.75–0.9 mm.

Coloration dark brown, sutures pale; pale spots on dorsum and on sides of body; spiracu disk pale, lobes marked with darker.

Form rather stout, terete (Plate XXXI, 132). Body densely covered with a long, appres dark pubescence. Prothoracic segment narrowed in front, long, divided into two rings a faint constriction; mesothoracic and metathoracic segments gradually longer. F abdominal segment shorter than last thoracic segment; abdominal segments 2 to 7 lo each divided into two narrow annuli by a deep constriction which is destitute of hairs l has just before it a sharp, transverse ridge of stiff hairs; short, incomplete ridges of th stiff hairs on dorsum of anterior ring; anterior ring about half as long as posterior ring; ventral side of each of segments 2 to 7 on anterior ring, a transverse swelling, these swelli becoming more convex and prominent on posterior segments; swellings appearing alm smooth, being covered only with microscopic, roughened points; posterior ring with a sh ridge of hairs at about two-thirds its length. Chaetotaxy as follows: dorsal segments w short setae at about midlength of posterior ring; a single rather stout, black bristle on pleu of anterior ring, immediately above transverse swellings; a similar seta on posterior rin two groups of very long, delicate setae on ventral face of posterior ring, one on each side the ridge of erect hairs; thoracic segments approximately similar to abdominal segments, l sternal setae at about midlength even more prominent. Last segment of body elongated, t spiracular disk (Plate XXXI, 136) surrounded by five lobes; dorsal lobe the smallest, rat blunt, inner face with a brownish, triangular-oval mark; lateral lobes of medium leng inner face suffused with brown, which is darkest, almost black, on lower edge of lobe; vent lobes the longest, inner face of each with two broad, parallel, blackish lines, separated a somewhat narrower pale line; entire disk fringed around with long, dark-colored hai which are longest near tips of lobes, where they are strongly recurved, almost pencil-lik fringe continuous between dorsal and lateral lobes, but between ventral and lateral lob and between the two ventral lobes, hairs toward base of each lobe very short to lacki ventral lobes just before tips with a single long sensory bristle. Spiracles large, subcircul situated at base of lateral lobes, dark-colored, narrowly margined with pale. Anal g consisting of two pairs of pale, stout, cylindrical lobes, tapering toward tips, before wh there is a slight constriction.

Head capsule massive and compact, of the normal generalized limnobiine type. Labr large, conspicuous, transverse, densely fringed with long hairs; on epipharyngeal regi a large, dense tuft of moderately elongate hairs on either side of median line. Ment (Plate XXXI, 133) not completely divided, but with a very deep split behind, a large med tooth, and two smaller teeth on either side; behind (dorsad of) elongate median tooth slightly wider flattened lobe whose margins extend beyond those of outer tooth. Hy

harynx a broad semicircular band of chitin whose anterior margin is provided with bout a dozen teeth, the intermediate ones more blunt and rounded, the lateral teeth longer nd more slender. (The antennae of this species were not distinguishable in the specimens vailable, but are undoubtedly similar to those of *R. flavipes* described hereinafter.) Mandible Plate XXXI, 135) of the generalized limnobiine type, short and stout, terminating in two lunt teeth; ventral cutting edge with about three teeth which are gradually smaller toward ase of mandible; a dorsal row of two teeth, of which the basal one is the smaller; base of nandible on outer face (heel) prolonged into an acute flattened blade; a conspicuous tuft f hairs at prosthecal region. Maxilla consisting of two rather short, stout lobes which re shorter than the mandible, densely provided with short hairs; palpi large, shaped like half of a short cylinder split lengthwise.

Pupa.— Very similar to that of *R. flavipes*, as described on the following pages. (The vriter has only the cast pupal skin of *R. mainensis*, and it seems to agree very closely with he pupa of *R. flavipes* except that the lobes of the labial sheaths are longer and more pointed, nd the labrum is a little longer to provide for the longer rostrum of the former species.)

Nepionotype.— Ithaca, New York, April 20, 1917.
Neanotype.— Cast pupal skin, May 14, 1917.

Rhamphidia flavipes Macq.

1855 *Rhamphidia flavipes* Macq. Dipt. Exot., 5th supp., p. 17.
1856 *Rhamphidia prominens* Walk. Ins. Saunders, vol. 1, Dipt., p. 435.
1859 *Rhamphidia brevirostris* O. S. Proc. Acad. Nat. Sci. Phila., p. 222.

Rhamphidia flavipes is a common and widely distributed fly thruout he eastern United States and Canada. The species is characteristic f cat-tail swamps and similar situations. It has been reared from leaves f bur reed, Sparganium, brought in by C. H. Kennedy from Ringwood Hollow, near Etna, New York, in September. These larvae were asso- iated with larvae of *Prionocera fuscipennis*, likewise a characteristic nhabitant of open swamps. The specimens here described were taken n a small cat-tail swamp near Bool's hillside, Ithaca, New York, in June, 917. Here they were associated with a number of larvae of characteristic wamp-inhabiting crane-flies, such as *Ptychoptera rufocincta*, *Pseudolimno- hila luteipennis*, *Limnophila macrocera*, *Pilaria recondita*, *Liogma nodi- ornis* (in moss), *Prionocera fuscipennis*, and *Tipula tricolor*.

This is unquestionably the larva that was found by Hart and doubtfully eferred by him to the genus Erioptera (Hart, 1898 [1895]: 197–199, also Malloch, 1915–17 b: 237). Later, Mik (1898: 62) doubted that this belonged o Erioptera because of the long lashes of hairs surrounding the caudal obes, a character not shown by typical eriopterine larvae. The larvae hat Hart found were living among rushes and other vegetation floating

on the surface of the water in the Illinois River. When submerged these larvae were very active, quite as noted in the account of *R. mainensis*.

Larva.— In all general features like larva of *R. mainensis* (with the material available the writer is unable to point out differences). Present species a little larger than *R. mainensis*, measuring from 12 to 13 mm. in length and 1 mm. in diameter. Mouth parts and head capsule almost exactly like those of *R. mainensis*, already described. Antenna (Plate XXXI, 134) with first segment elongate, a little enlarged toward tip, and with an elongate, thimble-shaped papilla at tip whose surface is delicately sculptured; surrounding this papilla at tip of basal segment, a few microscopic tubercles and pegs; on face of basal segment on proximal half, a circular porous plate.

Pupa.— Length, 7.8–8.8 mm.
Width, d.-s., 1 mm.
Depth, d.-v., 1.1–1.2 mm.

Coloration light brown; abdomen paler, trivittate with dark brown; a broad, dorso-median line, and narrower, somewhat interrupted, pleural stripes; breathing horns yellow, darker at extreme bases.

Cephalic crest (Plate XXXII, 137) low, the lobes divergent, their lateral angles with a stout seta which is directed cephalad. Just behind the anterior crest a much larger, low, appressed lobe, which is transversely wrinkled, bearing on its side a seta directed dorsad. Eyes rather large, widely separated by front; two setae on front between eyes. Labrum triangular, pointed at apex. Front a little elongated to provide for short rostrum of adult. Sheaths of maxillary palpi long, stout, almost straight. Labial palpi contiguous, lying side by side at tip of labrum. Antennae rather widely separated at their bases, ending just beyond wing root; in males lying across face of eye, due to the large size of eyes in this sex.

Mesonotum prominent, carinate medially (Plate XXXIII, 142). Breathing horns long and slender, slightly curved, transversely crenulated, a little enlarged toward tips; proximo-cephalad of base of each horn a small rounded tubercle bearing two setae. Lateral angles of thorax with about three short setae. Mesonotum convex, transversely wrinkled, with a few very short setae. Wing sheaths ending about opposite posterior margin of second abdominal segment. Leg sheaths parallel, about subequal in length or those of fore legs a little longer, ending just before posterior margin of fourth abdominal segment. Dorsal abdominal segments (Plate XXXIII, 143) each with two narrow basal rings and a much broader posterior ring; ventral segments (Plate XXXIII, 144) with the two basal rings confluent; dorsal segments with each narrow basal ring having a narrow, slightly arcuated band of spicules, and posterior ring having a narrow basal band of spicules which is more or less arcuated, and a straight caudal band, immediately in front of which are four groups of two setae each, or, in some specimens, with the intermediate groups reduced to a single seta; ventral segments with posterior ring having a broad transverse band of spicules, with three setae in alinement at each end of this band; closer to base of segment, two strong setae on either side; anterior ring darkened. Pleura with large but apparently nonfunctional spiracles on segments 2 to 7, a strong ante-spiracular seta, and three post-spiracular setae, as illustrated (Plate XXXIII, 144). Male cauda (Plate XXXII, 139 and 140) terminating in two acute tips which are directed dorsad; at base of these lobes on

al face, two blunt, approximated, parallel lobes directed cephalad; at the base of long al lobes, a shorter, pointed, setiferous lobe, directed laterad and dorsad, bearing on its and near the apex a few setae. Dorsum of segment 8 with four prominent lobes ounding a hollow, these lobes ending in acute tips, the posterior pair directed more dorsad, nterior pair directed more laterad, at the base of the latter a pair of spiracles. Female a similar but with acidothecae prolonged, bearing on the side prominent lateral lobes te XXXII, 141), corresponding to the setiferous lobe of male as described above; rangle of tubercles on dorsum of segment 8 (Plate XXXII, 138) about as in male, all ubercles ending in chitinized points.

epionotype.— Ithaca, New York, May 11, 1917.
eanotype.— Ithaca, New York, June 3, 1917.
aratypes.— Pupae with neanotype.

Tribe Hexatomini

he tribe Hexatomini, as here understood, comprises a very extensive up of medium-sized crane-flies, made up of the members of the former ups Limnophilini and Hexatomini. The more generalized members he group are herbivorous, but the two highest subtribes, Limnophilaria Hexatomaria, are carnivorous in their feeding habits.

he larvae of the lower divisions have the head capsule massive and pact, the mentum chitinized and with the anterior margin toothed, the hypopharynx usually well preserved. The mandibles are not ned into long, curved hooks, and the maxillae are of a generalized nization. The higher subtribes, Limnophilaria and Hexatomaria, e the head capsule long and slender and very much dissected, with constituent plates very narrow and separate. The mentum is very uced or lacking, in some of the Limnophilaria consisting of an articulated sverse bar which is grooved with parallel fine striae. In the group morphae and in the Hexatomaria the chitinized mental region is ly, if not quite, lacking, allowing for great distention of this region he head. The mandibles are powerful, curved hooks, bearing a few h at about midlength. In the group Ulomorphae the mandibles hinged at about midlength, the basal part being deeply grooved on inner face to receive the blade in a position of rest. The maxillae e the outer lobe prolonged into an elongate flattened blade which nds out of the thoracic orifice when the head is retracted.

he pupae of the Ularia and the Epiphragmaria have a pair of large acles on the dorsum of the eighth abdominal segment, indicating a e phylogenetic relationship with the Limnobiini. Dactylolabis has

the lateral abdominal spiracles protuberant, with those of the secon segment very large and conspicuous. Pseudolimnophila, the Ulomorpha and Pilaria have the pronotal breathing horns very long and slende with the tips split into divergent flaps. In the Hexatomaria the later abdominal spiracles are large and functional.

The immature stages of the Polymeraria, including the single tropic American genus Polymera Wiedemann, are unknown. Their discover might result in the inclusion of this subtribe with the Pediciini rath than with the Hexatomini.

The following keys separate the subtribes of the tribe Hexatomin

Larvae

1. Mentum completely divided, each half with seven teeth on anterior margin; hypophary a semicircular chitinized ring with numerous teeth around anterior margin. *Pseudolimnophilaria* (p. 84
   Mentum when present not divided; hypopharynx not shaped as above
2. Abdominal segments 2 to 7 with a basal transverse creeping-welt
   Abdominal segments 2 to 7 without such a welt
3. Mentum three-toothed; antenna elongate, the apical segment hemispherical. *Epiphragmaria* (p. 84
   Mentum nine-toothed; antenna short, subglobular, the apex with two short papillae. *Ularia* (p. 83
4. Body depressed; head capsule massive, compact; mentum heavily chitinized, seve toothed; maxilla not projecting *Dactylolabaria* (p. 85
   Body terete; head capsule of slender bars, not compact; mentum feeble, at most a narro transverse bar which is delicately striate; maxilla projecting from thoracic orifice
5. Mental bar present *Limnophilaria* (group *Limnophilae*) (p. 85
   Mental bar lacking
6. Dorsal plates of head capsule firmly united; epipharynx and maxilla densely hair mandible hinged *Limnophilaria* (group *Ulomorphae*) (p. 86
   Dorsal plates of head capsule widely separated, at most merely contiguous behin epipharynx and maxilla not hairy; mandible not hinged *Hexatomaria* (p. 87

Pupae

1. Two large spiracles on dorsum of eighth abdominal segment
   No large spiracles as above
2. Pronotal breathing horns subchitinized, directed strongly ventrad; abdominal segmen without shagreened transverse bands; pupates in wood *Epiphragmaria* (p. 84
   Pronotal breathing horns flattened, directed laterad; shagreened transverse bands abdominal segments; pupates in earth *Ularia* (p. 83
3. Abdominal segments with large protuberant spiracles, those on second segment ve large *Dactylolabaria* (p. 85
   Abdominal segments without conspicuous protuberant spiracles
4. Pronotal breathing horns elongate, split into two flaps at tip
   Pronotal breathing horns not split into two such flaps
5. Abdominal segments with five or six rows of setiferous tubercles. *Pseudolimnophilaria* (p. 84
   Abdominal segments without such rows of tubercles. *Limnophilaria* (group *Ulomorphae*) (p. 86

Head and thorax without spines or tubercles; lateral abdominal spiracles small. *Limnophilaria* (group *Limnophilae*) (p. 858)

Head and thorax often with tubercles on antennal scape, labrum, or mesonotal scutellum; lateral abdominal spiracles large, functional..... *Hexatomaria* (p. 876)

The most important literature on the tribe Hexatomini is as follows:

a macroptera	Larva	Stannius, 1829:205.
a macroptera	Larva, pupa, general.	Perris, 1849:337–341.
a macroptera	General	Alexander, 1915a:2.
a macroptera	General	Pierre, 1919–20:76.
a bolitophila	General	Loew, 1869:4–5.
a elegans	Larva, pupa, general.	Alexander, 1915a.
a elegans	Larva, pupa	Malloch, 1915–17b:226. (Copy.)
Ephragma picta	Larva	Bremi-Wolf, 1846.
Ephragma picta	Larva, pupa	Beling, 1873b:589–590.
Ephragma fascipennis	Larva, pupa, general.	Needham, 1903:281–285.
Ephragma fascipennis	Larva, pupa	Malloch, 1915–17b:224–225. (Copy.)
Eudolimnophila luteipennis	Larva, pupa, general.	Hart, 1898[1895]:202–204.
Eudolimnophila luteipennis	Larva, pupa, general.	Malloch, 1915–17b:222–223.
Ctylolabis wodzickii	Larva, pupa, general.	Nowicki, 1867:340–343.
Ctylolabis denticulata	Larva, pupa, general.	Mik, 1894.
Limnophila ferruginea	Larva, pupa, general.	De Meijere, 1916:204–206.
Limnophila hyalipennis	Larva, pupa	Beling, 1886:198–199.
Limnophila lineola	Pupa	Beling, 1879:54.
Limnophila lineola	Larva	Beling, 1886:199–200.
Limnophila nemoralis	Larva, pupa	Beling, 1886:200–201.
Limnophila ochracea	General	Beling, 1886:202.
Limnophila pallida	Larva, pupa	Beling, 1873a:556–558.
Limnophila dispar	Larva, general	Perris, 1849:331.
Limnophila pictipennis	Larva, pupa, general.	Beling, 1879:51–52.
Limnophila pictipennis	Larva	Brauer, 1883:55.
Limnophila punctata	Larva	Scheffer, in Rossi, 1848:10.
Limnophila punctata	Larva	Osten Sacken, 1869:201.
Limnophila punctata	Larva, pupa, general.	Beling, 1886:195–197.
Limnophila punctata	Larva	Gerbig, 1913:158–161.
Limnophila punctata	General	Cameron, 1917:63.
Limnophila bryobia	General	Mik, 1881:205–206.
Limnophila sinistra	Larva, pupa	Hudson, 1920:33–34.
Maria fuscipennis	Larva, pupa	Beling, 1886:197–198.
Maria fuscipennis	Larva	Gerbig, 1913:164–166.
Maria fuscipennis	General	Cameron, 1917:63.
Maria discicollis	Larva	Gerbig, 1913:163–164.
Maria discicollis	General	Cameron, 1917:63.
Maria tenuipes	Pupa	Hart, 1898 [1895]:204–205.
Maria tenuipes	Pupa	Malloch, 1915–17b:223–224.
Nocera spinosa	Larva, pupa, general.	Alexander and Lloyd, 1914:27–30.
Nocera spinosa	General	Alexander, 1915c:149.
Nocera cinerea	Larva	Alexander and Lloyd, 1914:21–23 (as *longicornis*).
Nocera longicornis	Pupa, general	Alexander and Lloyd, 1914:23–27.

Eriocera longicornis	General	Alexander, 1915c: 149–152.
Eriocera fultonensis	Larva, pupa, general	Alexander and Lloyd, 1914 33.
Hexatoma nigra	General	Von Röser, 1834.
Hexatoma megacera	Larva, pupa, general	Alexander, 1915c: 141–148.
Penthoptera albitarsis	Larva, pupa, general	Alexander, 1915c: 152–157.

Subtribe Ularia

The division Ularia includes only the genus Ula. It represents a v primitive group of crane-flies, presumably the most generalized of entire tribe. The head capsule of the larva is oval and very mas with the prefrons large and distinct. The head capsule and its arra ment of setae is not conspicuously unlike that of the eucephalous fam of crane-flies, and this group of Tipulidae is presumably not very diffe from the early tipulid ancestors. The mentum is heavily chitinized, completely divided behind, consisting of two plates, one behind the ot The outermost plate terminates in three teeth, while the second p furnishes three additional teeth on each side. The hypopharynx is chitinized. The antennae are very small; the basal segment is ne globular, bearing at its tip two blunt, conical papillae. The mandi are slender; the ventral cutting edge has about five narrow teeth; t is a distinct brush of hairs at the prosthecal region. The maxillae of a generalized type, with the palpus large, flattened, and disklike. abdomen is provided with six creeping-welts on the ventral surface of segments. The spiracular disk is moderate in size, squarely trunca surrounded by five subequal lobes which are heavily marked with bl on their inner faces.

The pupa has the cephalic crest small and provided only with v small setae. The pronotal breathing horns are very long, tapering the subacute tips. The abdominal segments have a basal transverse b of a shagreened appearance. The dorsal spiracles on the eighth abdom segment are large and distinct.

The closest relative of the division is apparently the genus Epiphra in the subtribe Epiphragmaria. But this entire group of genera (t included in the subtribes Ularia, Epiphragmaria, and Pseudolimnophila is not far removed from the tribe Limnobiini.

Genus Ula Haliday (Gr. *soft*)

1833 *Ula* Hal. Ent. Mag., vol. 1, p. 153.
1864 *Macroptera* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 9, p. 224.

Larva.— Body covered with a short pubescence. Basal annuli of abdominal segments 2 to 7 with a transverse creeping-welt on ventral surface. Spiracular disk squarely truncated, surrounded by five subequal lobes which are fringed with very short hairs. Head capsule massive, prefrontal sclerite very large, tapering to a point behind. Labrum large, conspicuous, with tufts of hairs. Mandible slender; ventral cutting edge with five teeth; a tuft of hairs on prosthecal region. Maxilla simple; palpus large. Antenna very small; basal segment subglobular, with two apical sensory papillae. Mentum not deeply divided behind; outer plate with three apical teeth; inner plate adding three additional teeth to each side. Hypopharynx not chitinized.

Pupa.— Cephalic crest small, setae tiny. Pronotal breathing horns long, tapering to subacute, flattened apices. Wing sheaths ending opposite base of third abdominal segment. Leg sheaths ending at about midlength of sixth abdominal segment. Abdominal segments on tergites and on apical sternites with transverse bands of microscopic points, producing a shagreened appearance; dorsal spiracles on segment 8 conspicuous.

The genus Ula includes only six described species, of which three are European, two are North American, and one is Javanese.

The adult flies of the American species are commonest in spring and late summer. They frequent cool, shaded gorges and ravines, or dark woods in mountainous regions, and may be swept from beds of low vegetation, such as ferns, yew, and other species.

The larvae of all the known species live in various species of fungi, but go to earth for pupation.

In Europe the common genotype, *Ula macroptera* (Macq.), has been discussed rather frequently in the literature. Stannius (1829:205) found the larvae in a species of Agaricus. Perris (1849:337–341) furnishes a brief account of the species, from which the following notes are taken: The fungus in which the larvae were found was *Hydnum erinaceum* Bull., growing on the trunks of living oak trees. The larvae are gregarious and frequent galleries in the fungus, along which they progress by means of their mandibles, by their ambulatory feet, and by the short hairs that cover the body. They were found in the month of November. A month later they went into the earth, where they transformed as pupae. The pupae bear a strong resemblance to those of Limnophila, but differ in the shape of the pronotal breathing horns. In February and March the pupae come to the surface of the earth and the adults emerge. The

caudal end of the larva is described as having but four lobes; no mentio is made of the median dorsal lobe found in the American species, and i is presumably lacking or very reduced in size. Pierre (1919–20:76) ha reared this species from larvae living in *Russula nigricans* Fries.

Another European species, *U. bolitophila* Loew, was bred from larva living in fungi on beech trees in Austria (Loew, 1869:4–5).

In America, the immature stages of *Ula elegans* have been discusse by the writer (Alexander, 1915a), the notes given below being in pa supplementary to his earlier account.

Ula elegans O. S.

1869 *Ula elegans* O. S. Mon. Dipt. N. Amer., part 4, p. 276–277.

Ula elegans is a rather common species in mountainous regions thruou the northeastern United States. The adult flies swarm in early sprin and again in the fall. At Ithaca, New York, on May 14, 1912, the writ found them swarming at half past four in the afternoon. There we about fifteen to twenty individuals in a swarm within a foot or two the ground. In some cases the swarms were reduced to two or thr individuals, or in a few instances to a single specimen. In copulatio the flies rest on the upper surface of near-by plants (Symplocarpus, in th instance cited), with all the legs on the support. Copulation is rath firm, and the insects fly for short distances still united. The only crane-fl associated with Ula at that time was *Limnophila ultima* O. S.

On September 15, 1912, the writer found a fleshy species of fung (Fomes) growing on a much-decayed stump close to the ground. Th fungus contained a number of crane-fly larvae, including about thirty-fi larvae of *Limnobia cinctipes*, a lesser number of *L. triocellata*, and man larvae of *Ula elegans*. The larvae of these species frequented the upp layers of the mushroom and had reduced the surface to a semi-liqui state. At the end of a week the whole fungus was reduced to a ve decayed condition. The fungus, which was taken at Gloversville, Ne York, was then transferred to Ithaca, and was placed in large glass jar with sand in the bottom to take up the liquids produced by decay a to provide a place for pupation. The first adults emerged on Octob 14. Emergence continued until the 27th, when the remaining pup were killed and placed in alcohol. At that time they were very dar

lored and evidently nearly ready to emerge to the adult state. At nes the larval movements are very active and eel-like, but at other nes they are very slow and sluggish. At each movement forward, e terminal segment partly telescopes into the subterminal and is thrown olently backward. After transforming to the adult condition, the pupal in is left adhering to the sand, with the posterior half, or a smaller rtion, attached, often standing quite perpendicular to the surface and ry conspicuous.

Larva.— Length, 8.5–11.9 mm.
Diameter, 1.4–1.8 mm.

Color dull white; head capsule very dark brownish black.

Form moderately slender (Plate XXXIV, 145), but the body not greatly elongated as in Eriopterini and some Limnobiini. Integument covered with a fine, short pubescence. dominal segments 2 to 7 each divided by a constriction into a narrow basal annulus and road posterior annulus; basal ring at about midlength and at the end with narrow trans-se rows of tiny setae; abdominal segments 2 to 7 on ventral surface of basal ring with spicuous raised transverse creeping-welts which are covered with microscopic points; nth abdominal segment suddenly constricted before spiracular disk. Region around anus tuberant, this evidently being an aid to propulsion. Spiracular disk (Plate XXXIV,) surrounded by five blunt lobes, of which the dorsal one is median in position and nter than the others; inner face of each lobe with a conspicuous brownish black mark; ringe of delicate blackish hairs surrounding disk, these hairs a little longer and more minent at ends of lobes. Spiracles almost circular, widely separated, the distance between m being about three times diameter of one spiracle. Disk between spiracles with an istinct arcuated line.

Head capsule (Plate XXXIV, 146) massive and compact, rather narrow, posterior incisions extending deeply into capsule. Prefrons very large, tapering gradually to a sharp point ind; numerous setae on prefrons and on other sclerites of capsule. Labrum (Plate XXXIV,) large, conspicuous; epipharynx and lateral margins strengthened by narrow bands hitin; lateral and anterior margins of labrum with a dense fringe of long hairs; an irregular ercle on dorsal surface on either side of labrum; epipharynx with a narrow transverse d of setae; juncture of clypeus and labrum with four setiferous punctures, two on either , the posterior pair a little the closer together; clypeal region with a dark transverse basal terminal band; base of clypeus with three setiferous punctures on either side. Mentum ate XXXIV, 148) almost completely undivided, the usual median split obliterated except ind; outermost mental plate terminating in three apical teeth, the median one of which is ttle shorter and broader than the other two; behind (dorsad of) outer plate, another similar e which adds three more teeth to each side of mentum. Hypopharynx not chitinized. enna (Plate XXXIV, 149) very small, short, cylindrical or subglobular, about as broad ong; at the tip two hyaline papillae shaped like immature mushrooms, the outer one ut twice the size of the inner one. Mandible (Plate XXXIV, 150 and 151) slender, ending blunt, slightly curved, apical point; on ventral cutting edge a row of about five flattened

teeth; the more apical ones larger, the basal one very broad and truncated; two or thre dorsal teeth, gradually lessening in size from tip of mandible toward base; two conspicuou tufts of long setae at prosthecal region; base of mandible on dorsal side with a large, some what curved, plate overlying head sclerites. Maxilla (Plate XXXIV, 152) with cardo lon and narrow, transverse, with three conspicuous setiferous punctures bearing long setae outer lobe short and stout, a little narrowed to tip; palpus rather large, flattened, disklik the truncated apex with several tiny hyaline pegs; inner lobe with a sensory bristle an an inner fringe of rather short hairs.

Pupa.— Length, 6.4–7 mm.
Width, d.-s., 1.2–1.3 mm.
Depth, d.-v., 1.2–1.6 mm.

Mouth parts, wing sheaths, and leg sheaths rather dark brown; thoracic dorsum an abdomen light yellowish brown; pronotal breathing horns dark brown, passing into lig yellow on apical third or quarter; mesonotal prescutum retaining its light color even in o pupae and those preserved in alcohol.

Cephalic crest (Plate XXXV, 155) represented only by a small bilobed protuberanc behind and between antennal bases, each lobe tipped with a very tiny seta. Labrum short bluntly rounded at tip. Labial lobes appearing as a large, roughly quadrate plate, a litt narrowed behind and with all angles rounded. Sheaths of maxillary palpi very long an slender, rather stout at base, tapering to blunt tip. Antennae not conspicuous, rathe widely separated at bases, ending just before or opposite origin of wing pad.

Pronotal breathing horns (Plate XXXV, 154 and 155) long and conspicuous, cylindrical gradually tapering to subacute and flattened apices; horns directed laterad and cephalad widely divergent. Thoracic dorsum without lobes or spines. Wing sheaths extending just beyond end of second abdominal segment. Leg sheaths extending to about midlengt of sixth abdominal segment; tarsal sheaths ending almost on a common level, the fore leg being a very little the longest, the middle legs a little shorter. Abdominal tergites with trans verse rows of scattered punctures; on tergites 2 to 6 a transverse band of subchitinized points producing a shagreened appearance; these bands located on basal rings of segments exceptin the last two, which are on extreme ends of segments 5 and 6; on sternites the bands appearin only on segments 7 and 8, the other sternites being largely concealed by the unusually lon leg sheaths; band on segment 8 very broad, but narrowly interrupted medially. Male caud with ventral lobes bluntly rounded and inclosing pleural appendages of adult (in full colored pupae these show thru the pupal skin as from twelve to fifteen strong, chitinize points on the inner posterior face); dorsal lobes (Plate XXXV, 157) very short and blunt, an closely approximated medially; on eighth tergite a broad rectangle of five lobes, includin an anterior and a posterior lobe on either side and a much broader anterior median lobe just proximad of anterior lateral lobes a large and distinct spiracle, in the cast skin with th large tracheal trunks still attached. Female cauda (Plate XXXV, 156) stout, tergal valve a little longer than sternal valves and a little upcurved.

Nepionotype.— Ithaca, New York, October 14, 1912.
Neanotype.— With type larva.
Paratypes.— Type locality, October 12 to 19, 1912.

Subtribe **Epiphragmaria**

So far as is known to the writer, the division Epiphragmaria includes y the genus Epiphragma. The immature stages are of a very primitive anization. The larvae have the head capsule broad and massive, h the posterior incisions very shallow. The labrum is broad, with eral tufts of hair. The mentum is heavily chitinized, entire, with y a single lateral tooth on either side of the median tooth. The popharynx is not chitinized but the entire surface is provided with rs of tiny spinous points, somewhat as in the Dicranoptycharia. The ennae have the terminal papillae hemispherical. The mandibles are greatly elongated; each has an apical tooth and two rows of lateral th. The maxillae are very simple in structure. The abdomen is vided with six ventral creeping-welts. The spiracular disk is large simple, with the lobes short and obtuse.

The pupa has the breathing horns heavily chitinized, tapering to acute, der points. The spiracles on the dorsum of the eighth abdominal ment are large and conspicuous.

The relationships of this group are obviously with the Rhamphidaria of Limnobiini and the Ularia of the Hexatomini, the three groups probably ng closer together phylogenetically than their arrangement in tribes uld indicate. From a study of the adults alone, there seems to be e connection between the genera Rhamphidia, Epiphragma, and Ula, ch were placed in three widely separated tribes by Osten Sacken. A dy of the immature stages, the structure of the larval head, the abdom- creeping-welts, and the dorsal spiracles of the eighth abdominal ment of the pupa, indicate a relationship that cannot be denied.

us **Epiphragma** Osten Sacken (Gr. *upon* + *partition*)

59 *Epiphragma* O. S. Proc. Acad. Nat. Sci. Phila., p. 238.

rva.— Body nearly smooth; basal annuli of abdominal segments 2 to 7 with a naked verse creeping-welt on ventral surface. Spiracular disk large, with four or five lobes, lorso-median lobe often reduced. Spiracles large, circular. Anal gills four, retractile. capsule massive. Labrum broad, with lateral tufts of hairs and with two setae on ior margin. Mandible with a blunt apical tooth and two rows of two lateral teeth. lla small, simple; palpus large; inner lobe with a dense tuft of stiff hairs. Antenna egmented; basal segment elongate, apical papilla hemispherical. Hypopharynx not ized. Mentum entire, with only three teeth — a slender median tooth, and a broad, ooth on either side.

Pupa.— Cephalic crest erect, rectangular, the outer lateral angles produced into str chitinized spines. Pronotal breathing horns large at base, the elongate tips nearly chitini tapering into subacute points. Wing sheaths ending opposite base of third abdon segment. Leg sheaths terminating just before end of fifth abdominal segment. Abdon tergites with a transverse band of spicules at caudal margin; pleurites with a transv oval area of similar spines; terminal sternites with a similar transverse band of spic most powerfully developed on segment 8; dorsal spiracles on segment 8 conspicuous.

Epiphragma is a rather small genus (twenty-five species) of usu large and handsome crane-flies, finding its center of distribution in tropical regions of the New World. The adult flies of the local spe are usually common. *Epiphragma fascipennis*, the best known of th species, is often found swarming in shady places, the swarms usu consisting of from twelve to fifteen individuals.

The immature stages of all the species thus far known are spent in dec ing wood. In Europe, Beling (1873b:589–590) records finding larvae pupae of *E. picta* (Fabr.) in decaying ash (Fraxinus) and beech (Fag in the spring. He gives the pupal duration of this species as about weeks. Needham (1903:281–285) gives an excellent account of *fascipennis*, which he found in partly decayed stems of willow and butt bush. The same species has been found living in the stems of bi ash and elm. *E. solatrix* has been found in various deciduous tree a dead or decaying condition. Bruch (*in litt.*) records an Argenti Epiphragma from decaying wood.

Epiphragma solatrix (O. S.)

1859 *Limnophila* (*Epiphragma*) *solatrix* O. S. Proc. Acad. Nat. Sci. Phila., p. 238

Epiphragma solatrix is a beautiful crane-fly, a little more Austra its distribution than the more widely distributed *E. fascipennis*. H Barber found larvae and young pupae very numerous in a drift lo sycamore (Platanus) at Plummers Island, Maryland, on May 19, 1 and it is the study of this material that is included in this paper. Shan found larvae in rotten wood at Rosslyn, Virginia, on November 23 25, 1912, and a pupa on January 3, 1913. Later he reared both *solatrix* and *E. fascipennis* from larvae taken from the same log on same day. The species was again found in a decaying maple log on Potomac River opposite Plummers Island, Maryland, where it was as-

d with the larvae of the syrphid fly, *Temnostoma bombylans* (Fabr.) l the supposed larva of Protoplasa (p. 770).

arva.— Length, 18 mm.
Diameter, 1.6 mm.

oloration pale whitish; anterior segments of body brighter-colored, more reddish. orm stout and plump, not narrowed at ends of body. Pronotum longer than other acic segments. Integument covered with a short appressed pubescence. Abdominal ents 2 to 7 with conspicuous white creeping-welts on ventral surface of basal ring; these s not interrupted medially, and entirely naked. Spiracular disk (Plate XXXVI, 163) e, unmarked, surrounded by five short lobes, the ventral pair very widely separated; al lobe broad and obtuse; entire disk fringed with very short, delicate hairs which are rupted only between paired lobes; inner face of lobes suffused with pale brown at tips. acles large, circular, reddish with a very broad yellow margin, separated by a distance y equal to two times the diameter of one spiracle. Anal gills four, retractile. ead capsule (Plate XXXVI, 158) broad and massive, the constituent plates firmly united ot on ventral parts. Labrum broadly transverse; a median epipharyngeal part whose ce is finely pitted, bearing on ventral side near margin two stout setae; lateral angles of m directed proximad and densely tufted with hairs; extreme lateral margins of labrum a curved hyaline seta; juncture of labrum and clypeus with two large setiferous punctures ther side; a few setiferous punctures on head capsule. Mentum (Plate XXXVI, 159) ly chitinized, the outer face terminating in a single median tooth, behind which is a ntate plate with three flattened teeth, the lateral ones very broad. Prementum (Plate VI, 160) lying just behind mentum; a moderately broad transverse plate whose ior margin is deeply and almost squarely notched, the lateral lobes thus formed being ded or feebly indented at their tips. Hypopharynx (Plate XXXVI, 161) lying above connected with prementum, consisting of a large flattened lobe, whose outer margin enly rounded, the surface densely set with longitudinal rows of small, subacute papillae. nna short, two-segmented; basal segment cylindrical, with auditory plate almost basal osition; apical segment small, subglobular or hemispherical. Mandible moderate in broad at base with a blunt apical tooth and a few blunt lateral teeth, two on dorsal ng edge and two on ventral cutting edge, the more basal of these latter tending to be escent; two stiff setae at heel of mandible; a triangular lobe on dorsal face which cts onto lateral parts of labrum. Maxilla (Plate XXXVI, 162) primitive in structure; elongate, transverse, with four setiferous punctures bearing powerful setae; outer lobe ous, with palpus at its tip; palpus slightly elongate, the auditory plate just before ngth; a seta on outer lobe below palpus; inner lobe of maxilla with a dense terminal of stiff yellow hairs and a few sensory papillae.

pa.— Length, 12–12.5 mm.
Width, d.-s., 2–2.1 mm.
Depth, d.-v., 2–2.1 mm.

ad, thorax, and appendages brown, becoming darker with age; pronotal breathing light red; abdomen whitish, the terminal rows of spicules on the segments chitinized.

(In older specimens the wing pattern shows on the sheath and is not distinctly fa
in *E. fascipennis*.)

Cephalic crest (Plate XXXVII, 166) erect, rectangular, the outer lateral angles
ventrad and laterad as powerful chitinized spines, which in most cases curve out
stout seta beneath each spine. Labrum subtruncated or indistinctly bilobed
Labial lobes triangular, projecting caudad as two cones. Maxillary palpi bent b
lying along margin of cheek, stout, tapering suddenly to blunt tips. Cheeks p
as flattened ledges. Antennae moderate in length, on scapal segment with a
tubercle on either side of cephalic crest; antennae extending rather far beyo
root.

Pronotal breathing horns (Plate XXXVII, 164) with base enlarged, the elongate,
nized tips gradually narrowed, and the extreme apices subacute; breathing horn
directed ventrad and proximad; a truncated setiferous tubercle before each breathi
Mesonotum very deep. A short, but high, median crest behind b-eathing horns.
angles of thorax produced into a slender lobe bearing a stout seta at tip. Wing
ending opposite base of third abdominal segment. Leg sheaths terminating just be
of fifth abdominal segment; middle tarsal sheaths usually a little shorter than the o
some specimens, especially females, fore legs the shortest, hind legs the longest. A
segments (Plate XXXVII, 167) with two narrow basal rings and a broader poster
Tergites on segments 2 to 7 near caudal margin of posterior ring with a narrow tr
crossband densely beset with acute spicules; on posterior segments these bands b
gradually weaker, on segment 7 being very weak; two setae near lateral margin of
ring at about midlength. Pleurites with a transverse oval area with about twenty sha
near caudal margins of segments; a stout seta lying cephalad of this area. Spiracles
oval, lying on ventral cephalic part of pleural posterior ring; a seta near dorsal m
second basal ring. Sternites with a transverse band of spicules on segments 5 to
being weakest on segment 5 at ends of tarsal sheaths and very strong and powerfu
ment 8, where the band is interrupted medially; band often rather narrow but s
much broader. A seta near midlength of posterior ring on either side. Male cauc
XXXVIII, 170) with dorsal lobes very stout, globose at base but soon narrowed int
cylindrical appendages, each bearing three setae at tip; viewed from above, these l
seen to be separated by a wide U-shaped notch; ventral lobes blunt and with a
depressed disk at base of incision; eighth segment with a wide rectangle of lo
posterior lobes that are weakly setiferous and two smaller anterior lobes with
spiracle proximad of each. Female cauda (Plate XXXVIII, 171) with tergal valve
longer than sternal valves, upcurved, and with a stout seta before tip.

Nepionotype.— Plummers Island, Maryland, May 19, 1913.
Neanotype.— With type.
Paratypes.— Larvae and pupae with type.

Epiphragma fascipennis (Say)

1823 *Limnobia fascipennis* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 19.
1859 *Limnophila* (*Epiphragma*) *pavonina* O. S. Proc. Acad. Nat. Sci. Phila.,
1869 *Epiphragma fascipennis* O. S. Mon. Dipt. N. Amer., part 4, p. 194.

Epiphragma fascipennis is a very common crane-fly thruout eastern rth America. As already stated, the immature stages are spent in aying or partly sound wood, a wide variety of deciduous trees and ubs being chosen, such as willow, elm, ash, buttonbush, and others. edham gives the pupal duration as about twelve days, larvae and pae found on May 18 emerging as adults on the 30th. A fully grown va that the writer found in a decayed log beneath moss at Ithaca, w York, on May 8, 1917, pupated early in the morning of the 10th. e specimen died on the 18th, when about to emerge, and this would e a much shorter pupal period than is generally recorded for the genus. was noted at the same time that the larva superficially resembles the va of the leptid fly *Chrysopila thoracica* (Fabr.), with which it was ociated but from which it is easily distinguished by its massive head sule.

Needham found abundant pupae in a decaying log of black ash (Fraxinus) r Freeville, New York, on May 6, 1915. The pupae occurred in bur-s in the semi-decayed wood. Adults emerged on the 11th. Additional terial was found at Mud Creek, near Freeville, on May 15, 1915, in (Ulmus).

The account of the habits of the larvae as observed in Illinois by edham (1903:281–285) is here quoted in part:

he larvae bore in the dead and fallen stems of buttonbush and willow, where these lie he mud at the borders of shallow ponds. I found them always in stems that were still ially sound, tunneling beneath the bark or even into the deeper parts and into the der wood. These stems are frequently submerged in spring and autumn, and even mmer, when the pond has gone dry, they are always saturated with moisture. . . . he most interesting thing about the larva, aside from its wood-boring habits, is its singular otation to amphibian life. It must needs live part of the time wholly submerged beneath waters of the pond, and part of the time out on land; it has, therefore, both open spiracles tracheal gills; and, moreover, its tracheal gills are so placed that they may be with-wn into the body in a dry time, where they escape the ills of too rapid evaporation.

n his description of the immature stages, Needham points out a bable error of Beling in describing a sexual dimorphism in the larvae a species of this genus — Beling stating that the larvae producing ales have three caudal lobes while those producing males have five. lloch (1915–17b:224–225) cites Needham's descriptions of this species.

rva.— (No larvae are available to the writer for a comparison with this stage of *phragma solatrix*, but from Needham's characterization, and manuscript notes on speci-s taker at Ithaca, New York, by the writer, the following differences seem to hold):

Spiracular disk surrounded by but four lobes, the dorso-median lobe being very reduce inner faces of these lobes, as well as disk itself, entirely unmarked with darker.

Pupa.— Similar to pupa of *Epiphragma solatrix*, but differing as follows:

Cephalic crest (Plate XXXVII, 165) low, the lateral horns shorter, not elevated, a directed ventrad or slightly downward; setae on lateral face of spines often projecti above (cephalad of) it. Pronotal breathing horns shorter and stouter than in *solatri* Spines on eighth abdominal sternite widely separated or interrupted on median line. Ma cauda (Plate XXXVIII, 169) with dorsal lobes much stouter than in *solatrix*.

Neanotype.— Bool's hillside, Ithaca, New York, May 8, 1917.
Paratype.— Pupa, Mud Creek, Freeville, New York, May 15, 1915.

The type pupa has one of the pronotal breathing horns deformed an bent caudad so as to be appressed against the body. Needham, wh has a very much larger series available for study, notes this same peculiarit when he states that "a crumpled horn on one side is of rather commo occurrence" (Needham, 1903:284).

Subtribe **Pseudolimnophilaria**

As at present constituted, the division Pseudolimnophilaria includ the single genus Pseudolimnophila, but other groups may be added t it when the immature stages of other species of the old genus Limnophil are made known. The larva is of a distinctly primitive type, the hea capsule being compact and massive, the mentum chitinized and con pletely divided, each half provided with seven or eight teeth. Th hypopharynx is a heavily chitinized semicircle with numerous teeth arou the anterior margin. The antennae bear two elongate apical papilla The mandibles each have two blunt apical teeth and two rows of later teeth.

The pupa is similar to that of the Limnophilaria, but the abdomin segments have transverse rows of setiferous tubercles.

The larva shows many points of resemblance to the tribe Limnobiin and the two groups are probably derivable from an immediate commo ancestor.

Genus **Pseudolimnophila** Alexander (Gr. *false* + *Limnophila*)

1919 *Pseudolimnophila* Alex. Cornell Univ. Agr. Exp. Sta., Mem. 25, p. 917.

Larva.— Body covered with delicate appressed hairs and numerous erect setae. Spiracul disk surrounded by four lobes, the ventral pair very long and narrow, with long fringes hair. Gills four, long and slender. Head capsule massive, the sclerites large, fuse

Mandible short and blunt, of the generalized limnobiine type, the two apical teeth blunt. Maxilla not greatly projecting. Antenna slender, with two elongate apical papillae. Hypopharynx a chitinized band, with numerous teeth along anterior margin. Mentum completely divided, each half with about seven teeth.

Pupa.— Cephalic crest tipped with long setae. Pronotal breathing horns elongate, lobes deeply split into divergent flaps. Abdominal segments with transverse rows of setiferous tubercles, there being five such rows on the tergites and six on the sternites. Lateral spiracles protuberant.

The name *Pseudolimnophila* was proposed for a certain group of the old genus Limnophila, including *L. luteipennis* and its allies. The adult flies closely resemble species of Limnophila, but the immature stages are very different and of a distinctly more generalized type.

The larvae are herbivores, with the mentum heavily chitinized, completely divided into two halves, the margin conspicuously toothed, the hypopharynx heavily chitinized and with numerous teeth, and the mandibles short and blunt and with many obtuse teeth. The points of resemblance to the Limnobia type are numerous, and the head capsule shows few features in common with Limnophila, in the restricted sense. The pupae have the abdomen with numerous transverse rows of setiferous tubercles bearing long setae. The genotype is *Limnophila luteipennis* O. S., of eastern North America. Other species referable to this genus are *L. inornata*, *L. contempta*, *L. nigripleura*, and *L. noveboracensis*, of the Nearctic fauna; *L. lucorum* (Meig.), of Europe; and *L. frugi* Bergr., *L. cladurone ura* Speis., *L. natalensis* Alex., *L. spectabilis* Alex., and several other species, of the Ethiopian fauna.

Hart (1898 [1895]:202–204) describes the habits of *P. luteipennis* in some detail. Larvae about half grown were found on March 17, 1895, these attaining their growth and pupating on April 13. Hart ascertained by dissection that the species is a herbivore, feeding on fragments of dead vegetation, numerous diatoms of many species, and minute algae.

As in many species of the Limnophilaria and a few other groups of crane-flies, the spiracular lobes are fringed with long, delicate hairs which spread out on the surface film of the water into broad fans. The larva is unable to release itself from the hold of the water except by looping the head and the anterior end of the body around the posterior end, and drawing the latter thru this loop, repeating this action until the hairs have gone below the level of the film.

It is probable that other groups of species of the old genus Limnophil will be found to deviate from the characters of this group as now restricted Species such as *L. hyalipennis* (Zett.), *L. nemoralis* (Meig.), and others i Europe, and *L. brevifurca*, *L. emmelina*, *L. mundoides*, *L. toxoneura L. ultima*, and similar anomalous forms in America, should be investigate critically when opportunity offers.

Pseudolimnophila luteipennis (O. S.)

1859 *Limnophila luteipennis* O. S. Proc. Acad. Nat. Sci. Phila., p. 236.

Pseudolimnophila luteipennis is one of the most abundant species the tribe, and is very widely distributed thruout eastern North Americ The adult flies are common in swamps and along the marshy edges streams and ponds. The immature stages are characteristic swam inhabitants. They have been described in detail by Hart (1898 [1895] 202–204). Malloch (1915–17 b: 222–223) adds several supplementary not and figures of Hart's material.

Larva.— Length, 15–18 mm.
Diameter, 1.5–1.7 mm.

Coloration light brownish yellow, slightly darker toward posterior end of body.

Body covered with a delicate appressed brownish pubescence and abundant stiff bristl and erect hairs on each segment, arranged in about five transverse rows; these bristles mo numerous, coarser, and blacker, on posterior segments, forming a large tuft on sides penultimate segment of body. Spiracular disk (Plate XXXIX, 176) surrounded by fo lobes, the posterior pair very long and slender, finger-like, the lateral pair much shorter b slender; the inner face of these lobes with brownish black or dark brown transverse lines whi cover almost the entire face; an arcuate line extending from ends of ventral marks across dis between spiracles; two small triangular marks located between ventral lobes; lobes fringe with long, delicate hairs, those at ends very elongate, those toward base of lobes shorten but continuous around disk. Anal gills four, very long and slender, exceeding ventral lob of spiracular disk.

Head capsule short and stout, exhibiting a very generalized condition. Prefrons ver broad, only slightly narrowed behind and but slightly exceeding lateral plates. Labru broadly transverse, with a large tuft of hairs on either side. Mentum (Plate XXXIX, 17 completely divided, each half with seven (or rarely eight) teeth along anterior margin, which the third (or fourth) from the inside is the largest; a flattened lobe just laterad of eac half of mentum; mental plates continuous behind with strong lateral plates of capsule; i a normal position the two halves of mentum overlying each other to a greater or less degre Hypopharynx (Plate XXXIX, 173) with anterior margin broadly rounded, with numero (from ten to fifteen) bluntly rounded teeth. Antenna slender, with two long apic papillae. Mandible (Plate XXXIX, 175) short and broad, of the generalized limnobii

e; tips blunt, ending in two large approximated teeth, with a row of smaller lateral teeth ending basad of each; ventral cutting edge with about four such lateral teeth, dorsal edge h one or two much larger teeth; two strong setae near base of scrobe, and two others near of mandible; a large brush of hairs at prosthecal region. Maxilla not projecting, with se brushes of short, stiff hairs and with two short sensory tubercles which are tipped with y elongate setae; palpi stout and chitinized at base, the apex narrowed and pale.

Pupa.— Length, 10–13 mm.
Width, d.-s., about 1.5 mm.

Thorax reddish brown to black in color, depending on age of specimen; abdomen dirty tish with narrow transverse brownish lines, both above and below; pronotal breathing ns dark brown or blackish.

Form subcylindrical, abdomen slightly depressed. Cephalic crest of two slender tubercles ind, tipped with long setae; another pair of setae between antennal bases. Pronotal athing horns elongate, transversely ringed, the tips widely and deeply split into two ergent flaps. Prothorax with a prominent median carina. A tubercle in front of each athing horn, each with about four stout setae. Mesonotum above wing axil with a ercle bearing three setae. Wings reaching end of second abdominal segment. Legs hing end of third abdominal segment, the tarsi ending about on a level or those of fore a little longer than those of other two pairs.

bdominal segments divided into two annuli, the basal one still further subdivided into ulets; on tergum three annulets, each bearing a transverse row of setiferous tubercles, the e very long and conspicuous, in some cases the tubercles multisetose, third annulet n two widely separated, slender, elongate tubercles. Posterior annulus with a basal a terminal transverse row of setiferous tubercles. On sternum, four transverse rows of ferous tubercles on basal ring and two on posterior ring. On pleura, protuberant spiracles. eral angles of segment 8 jutting out into stout lobes which are densely studded with ferous tubercles, on ventral face continued toward median line as a nearly straight row bout eight setiferous tubercles, on dorsum a finger-like lobe on either side: Male cauda te XL, 178) with sternal valves shorter than dorsal lobes, blunt at tips; tergal valves ely pointed, directed dorsad. Female cauda (Plate XL, 179 and 180) with tergal valves siderably longer than the more slender sternal valves, broad medially, tapering to the d, blunt tips which terminate in blackened points; two setae on outer margin.

Lepionotype.— Larch Meadows, Ithaca, New York, April 20, 1917.
Leanotype.— Female pupa, with type. No. 19–1917.
Paratypes.— Larvae with type. Pupae of both sexes from Bool's hillside, Ithaca, New York, June 6, 1917. A female pupa, Orono, Maine, taken as a larva June 13, 1913, emerged June 22. Female pupa, July 15, 1913, No. 75–1913.

Pseudolimnophila inornata (O. S.)

1869 *Limnophila inornata* O. S. Mon. Dipt. N. Amer., part 4, p. 219, 220.

Pseudolimnophila inornata is not so common as *P. luteipennis* but is nd in similar situations. The immature stages are spent in rich organic d. The only specimens that the writer has reared were taken in

Larch Meadows, near Ithaca, New York, on May 15, 1917, where th were associated with larvae of *Rhamphidia mainensis*, *Pseudolimnoph luteipennis*, *Tipula dejecta*, and other swamp-inhabiting species.

Larva.— Very similar to that of *P. luteipennis*, but body is darker and is conspicuou blotched with whitish, especially on posterior parts of ventral segments. Mouth pa nearly the same in the two species. Antenna (Plate XXXIX, 174) with two very long a slender terminal papillae, one blunt at tip, the other much longer and tapering gradu to tip.

Pupa.— Very similar to that of *P. luteipennis*, but somewhat smaller and darker-color Pronotal breathing horns (Plate XL, 177) darker brown, the divergent terminal flaps p portionately a little more elongate, equal to almost one-quarter length of entire horn. Dor lobes at base of ovipositor more attenuated.

Nepionotype.— Larch Meadows, Ithaca, New York, May 15, 1917. No. 53–1917.
Neanotype.— Larch Meadows, Ithaca, New York, May 25, 1917. No. 53–1917, pupal skin.

Subtribe **Dactylolabaria**

The division Dactylolabaria is proposed for the genus Dactylolab a small group of curious crane-flies which are still not well understoo The adult flies bear a striking resemblance to species of the genus Li nophila, but the larvae and the pupae show characters that are not fou in the more specialized divisions of the Hexatomini. The type of t genus is *Limnophila montana* O. S. of the eastern United States. Oth Nearctic species included are *L. damula* O. S. (western United State *L. rhicnoptiloides* Alex. (northwestern Canada), *L. cubitalis* O. S. (easte United States), *L. nitidithorax* Alex. (western United States), and *hortensia* Alex. (western Canada).

The immature stages of two European species — *D. wodzickii* (Nov and *D. denticulata* Bergr.— have been made known by Nowicki (186 340–343) and by Mik (1894), respectively. Their descriptions of t details of the larval head and the lateral spiracles of the abdomen of t pupa are incomplete, however. The larvae of none of the Americ species have as yet been made known, but the pupae of *D. cubitalis* O. were found by Needham and are described hereinafter.

Genus **Dactylolabis** Osten Sacken (Gr. *finger forceps*)

1859 *Dactylolabis* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

Larva.— Body very depressed, the ventral surface, especially, being greatly flatten Head capsule compact; mentum not completely divided, its anterior margin with se teeth. Mandible with but few lateral teeth.

Pupa.— Somewhat similar to pupae of Limnophilaria. Pronotal breathing horns short l cylindrical. In some species, at least, second abdominal segment with a very large and minent lateral spiracle.

Dactylolabis is a small genus including about thirteen known species ich are about equally well distributed in Europe and North America.

ctylolabis denticulata (Bergr.)

1891 *Limnophila denticulata* Bergr. Mittheil. Naturf. Ges. Bern, p. 132.

The present knowledge of the life history of *Dactylolabis denticulata* due to the work of Mik (1894), whose paper is cited by other workers, ong them Grünberg (1910:54–55).

Larvae and pupae were found on the dark brownish gray chalk cliffs ar Steiermark on August 3, 1891. In certain places on the cliffs were oad or narrow bands of black. The larvae and the pupae were found ng these dark bands and showed a decided resemblance to their sur-ndings. The surface of the rock was wet with dripping water, which pported a flora of lowly plant organisms on which the larvae presumably . The adherence of the pupa to the last larval skin is of interest since presumably aids in the emergence of the adult. A similar condition found in Cylindrotoma.

arva.— Length, 7 mm.
Width, 2 mm.

orm very depressed (Plate XLI, 183), the ventral surface flattened, almost leechlike. h dorsal and ventral surface provided with hairs, with longer and more numerous hairs sides of body. Body covered with small, black, structureless particles of earth or excre-at, more numerous near margins of dorsal surface, these particles lacking a definite arrange-at and being very firmly attached to the body hairs; when particles are removed, larva f a greenish gray color, subhyaline. Abdominal segments divided into two rings bearing g hairs which are more conspicuous on sides of body. Head capsule (Plate XLI, 182) ll but compact, completely retractile within prothoracic segment. Labrum relatively e and semitransparent, the margins with long hairs; on dorsum on either side a long cate seta. Mentum chitinized; anterior margin with seven teeth, behind median tooth rush of hairs. Antenna two-segmented; basal segment cylindrical; second segment ton-like, with apex pointed. Mandible three-toothed; a tuft of hairs at prosthecal region. racular disk surrounded by two fleshy welts which are deeply incised medially to appear our blunt lobes. Spiracles difficult to distinguish in a position of rest, elliptical, margined n blackish brown.

Pupa.— Length, 8 mm.
Width, 1.75 mm.

Coloration blackish; abdomen dark greenish gray.

Pupa (Plate XLI, 181) attached to old larval skin, which in turn remains attached t rock surface. (Just before pupating, the larva sticks itself to the surface by means of i saliva.) Pronotal breathing horns cylindrical, a little swollen at ends. Sheaths of appen ages dull and black in color. Leg sheaths attaining end of fourth abdominal segment.

Dactylolabis wodzickii (Now.)

1867 *Rhicnoptila wodzickii* Now. Verh. Zool.-Bot. Ges. Wien, vol. 17, p. 337–354.

The species *Dactylolabis wodzickii* was first found in the high Alpin region of the Hungarian Tatras, at an altitude of from 6000 to 8000 fee in a region frequented by the wall creeper (Tichodroma). Here t adults and the immature stages were found together on the granite cliff where water dripped continuously, supporting a considerable algal flor Associated with the species were other flies, *Liancalus virens* (Scop.) an *Clinocera fontinalis* Hal., as well as *Tricyphona schineri* (Kol.). Th degenerate wings of the insects prevent their flying, and they probabl live and die close to the place where the eggs are deposited. One fly wa observed laying her eggs in the masses of algae in this situation. Th larvae live in these masses and pupate in them.

Larva.— Length, 12.5 mm.
Width, 2.4 mm.

Dorsum of body dark greenish brown, with dark longitudinal brown stripes producing curious pattern of straight and convergent lines; ventral surface almost white, unmarke

Body depressed, flattened, abdominal segments divided into a narrow basal and a muc broader posterior annulus. Head capsule (Plate XLI, 185) compact, massive. Mandib showing but a single inner tooth. Posterior abdominal annuli with two long setae on later margins. Spiracular disk (Plate XLI, 186) surrounded by four lobes, the ventral pair longe than the others; these lobes margined with darker chitinized lines and provided with fringe of moderately long hairs. Spiracles not described, and undoubtedly overlooked by th describer.

Pupa.— Length, 12.5–13.5 mm.
Width, 2.6 mm.

Color brown. Pronotal breathing horns short, cylindrical. Wing sheaths ending opposit middle of second abdominal segment. Leg sheaths ending beyond middle of third segment Abdomen armed with rows of spines (Plate XLI, 184).

Dactylolabis cubitalis (O. S.)

1869 *Limnophila cubitalis* O. S. Mon. Dipt. N. Amer., part 4, p. 229.

Dactylolabis cubitalis is a local species, often occurring in great numbers In the gorge of Fall Creek near the Cornell University campus this specie

n be found in myriads by sweeping the rank herbage in May. The riter has never located the immature stages, but the species was reared Dr. J. G. Needham at Ithaca, New York, on May 20, 1898. There no record as to where these larvae occurred, but they are presumably ud-inhabiting forms, or possibly they frequent habitats similar to those scribed for the two preceding species.

Pupa.— Length of cast skin, about 12 mm.

Pronotal breathing horns (Plate XLI, 187) short, cylindrical, the tips scarcely enlarged. esonotum behind with a prominent rounded tubercle on either side of median line, which set with two spines, a larger outer spine and a small inner spine. Wing sheaths ending posite apex of second abdominal segment. Leg sheaths ending opposite apex of third dominal segment, the tarsal sheaths terminating on a common level.

Abdominal segments divided into two rings. Tergites with posterior ring having a nsverse row of elongate tubercles, there being about eight on segment 2, about six on ermediate segments (3 to 5), and about four on segments 6 and 7; these tubercles fleshy, sparsely armed with chitinized spines. Basal ring unarmed. Pleura with a strong ercle on each ring; a blunt but prominent spiracle at extreme base of posterior ring; this racle very prominent on segment 2 (Plate XLI, 188), much exceeding lateral tubercles l being about two-fifths length of pronotal breathing horns. Sternites with about six ercles on posterior ring. Male cauda (Plate XLI, 189) with tergal lobes slender, running into acute chitinized points, which are directed caudad, slightly divergent; dorsum of ment 8 with posterior lobes powerful, about equal in size to, or a little larger than, tergal es of cauda just described; anterior lobes small, directed caudad and laterad; two large ral lobes and two smaller ventral lobes. Female cauda with tergal valves moderately gate, stout, broad at base, narrowed toward tip, where they run out into long, chitinized nts directed caudad and slightly dorsad.

Neanotype.— Cast pupal skin, Ithaca, New York, May 20, 1898.
Paratype.— Pupae, cast skins, with type.

ctylolabis montana (O. S.)

1859 *Limnophila montana* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

The species *Dactylolabis montana* is common and widely distributed ruout the northern United States. It is a characteristic inhabitant of ky cliffs, where it rests in crevices on the almost vertical walls. The mature stages have long remained unknown, but during the spring 1920 W. L. McAtee found a pupal skin and the teneral adult near shington, D. C. Mr. McAtee writes that the pupa was found in the ss that covers the almost vertical north face of a cliff on Plummers and; this moss is mostly shaded, and grows on a thin layer of black soil ich, at that time of the year at least, is saturated with water. The

pupal skin was not in condition for study, but now that the larval habitat is known it is hoped that more material of the immature stages will become available.

Subtribe **Limnophilaria**

The division Limnophilaria comprises a large and heterogeneous group of species which in their larval and pupal characters grade rather insensibly into the next subtribe, the Hexatomaria, altho the adults of the two subtribes are very distinct.

The larvae of the various species in the group Limnophilae are rather similar to one another. The head capsule is long and narrow, with the lateral plates very slender. The labrum is ample, with several sensory papillae and setae. The antennae (which are two-segmented in the subgenera Phylidorea and Lasiomastix, and probably also in Dicranophragma and others) bear at their tips, in addition to the usual elongate setae, an oval or elongate-oval papilla which is delicately sculptured. The mental region is feebly chitinized, and consists of two short longitudinal bars articulated at their cephalic ends with a transverse bar which functions as the mental plate; this bar, or plate, is usually delicately grooved with parallel striae, a type of articulation that allows for great distention of the gular region in feeding. The mandibles are powerful chitinized hooks bearing two or more acute or flattened teeth at about midlength. The outer lobes of the maxillae project far cephalad as pale flattened blades.

The spiracular disk, in the primitive condition, is squarely truncated and is surrounded by five subequal lobes which are fringed with rather short hairs. The dorso-median lobe is lost in most species, but the two pairs of lobes are more or less preserved in the other species known to the writer, altho the lateral pair is sometimes reduced to a mere fringe or tuft of hairs. The terminal fringes of the ventral lobes are often greatly elongated, and fanlike. The anal gills are four in number, retractile, and rarely conspicuous. As is usual in many mud- or sand-inhabiting species of Tipulidae, the larvae are capable of greatly distending the subterminal abdominal segment. This segment is often provided with numerous transverse rows of fine points, and its inflation assists in the larva's progression thru the soil.

The larvae of the group are carnivorous, and almost without exception are exceedingly agile and snakelike in their motions.

The pupae of the group Limnophilae have the pronotal breathing horns sually small, or at least not greatly elongated. The abdomen is often reatly depressed, with the lateral margins flattened and carinate and ne segments incised. In the species of the subgenus Phylidorea the egments of the abdomen are armed with rows of long, slender spines.

The group Ulomorphae seems to be closely related to the other members f the division, but the immature stages present some curious conditions hich it is difficult to correlate with the same structures in the group imnophilae. The writer has removed a group of species from the old enus Limnophila, and has placed these in the genus Pilaria Sintenis.

In the larvae of the group Ulomorphae, the epipharynx and the maxillae re densely hairy. The maxillary lobes are slender. The mandibles re hinged at about midlength, the basal segment being concave on its nner face to receive the mandibular blade when in a position of rest. he mandibular blade has one, or sometimes two, elongate acute teeth t the base. The mental region is not chitinized. The spiracular disk surrounded by four lobes, of which the lateral pair are often very educed; the inner faces of the lateral lobes are capable of close approxi- nation, so that when they are closely applied the spiracles are contiguous. he pupae have the pronotal breathing horns very elongate, with their ps split into two flattened divergent lobes, as in Pseudolimnophila and few tipuline forms.

The following keys separate the genera and the subgenera of the subtribe imnophilaria:

Larvae

Mental region not chitinized; maxillae and epipharynx fringed with conspicuous, long, golden-yellow hairs; mandibles hinged; head capsule with dorsal plate spatulate at its tip. (Group *Ulomorphae*, p. 869) 2

Mental region a narrow, transverse, chitinized bar, finely striate; maxillae and epipharynx without conspicuous hairs; mandibles not hinged; head capsule not as described above. (Group *Limnophilae*, p. 858) 3

Length under 12 mm.; basal tooth of mandibular blade nearly half the length of blade. *Ulomorpha* O. S. (p. 869)

Length over 14 mm.; basal tooth of mandibular blade about one-third or less the length of blade ..... *Pilaria* Sint. (p. 872)

Spiracular disk almost squarely truncated, surrounded by five subequal lobes producing an eriopterine appearance ..... *Dicranophragma* O. S. (p. 861)

Spiracular disk obliquely truncated, surrounded by two pairs of lobes of which the lateral pair are the shorter 4

Mandibles with two or three acute teeth at about midlength; epipharynx with a circular area bearing two biarticulate papillae ..... *Phylidorea* Bigot (p. 866)

Mandibles with three or four flattened and truncated teeth along blade; epipharynx without papillae as above ..... *Lasiomastix* O. S. (p. 863)

Pupae

1. Pronotal breathing horns very long, cylindrical, the tips split into divergent flaps (Group *Ulomorphae*, p. 869).....
   Pronotal breathing horns not elongate-cylindrical. (Group *Limnophilae*, p. 858).....
2. Abdominal segments with tubercles or spines only near posterior margins of segments *Ulomorpha* O. S. (p. 869
   Abdominal segments with three or four pairs of blunt, naked tubercles. *Pilaria* Sint. (p. 872
3. Abdominal segments depressed, lateral margins flattened, carinate, segments deeply incised.....
   Abdominal segments not depressed nor incised; pronotal breathing horns bicolored. *Dicranophragma* O. S. (p. 861
4. Abdominal segments with rows of acute slender spines; pronotal breathing horns very short, semicircular in outline, bluntly rounded at their tips. *Phylidorea* Bigot (p. 860
   Abdominal segments without such slender spines; pronotal breathing horns short, broad, slightly compressed, tips a little pointed..... *Lasiomastix* O. S. (p. 863

Group Limnophilae

Genus **Limnophila** Macquart (Gr. *swamp* + *friend*)

1834 *Limnophila* Macq. Suit. à Buff., vol. 1, Hist. Nat. Ins., Dipt., p. 95.
1854 *Phylidorea* Bigot. Ann. Soc. Ent. France, p. 456.
1861 *Limnomya* Rond. Dipt. Ital. Prodr., vol. 4, p. 11.

Larva.— Form slender. Spiracular disk surrounded by five, or more commonly four, lobes, the ventral pair the longer and fringed with long, delicate hairs. Anal gills four, not conspicuous. Head capsule flattened, very dissected, with plates narrow. Mandible not hinged, curved, chitinized, on cutting edge with a few acute or flattened teeth. Maxilla with outer lobe produced into a flattened projecting blade. Antenna two-segmented, at its tip with a short or elongate-oval papilla which is delicately sculptured. Mentum a transverse chitinized crossbar which is finely grooved.

Pupa.— Cephalic crest setiferous. Pronotal breathing horns usually small, flattened, tips not split. Mesonotum convex or flattened above. Abdominal segments in some cases armed with tubercles or spines.

The genus Limnophila comprises a very extensive group of crane-flies (more than one hundred and fifty species), which are found in most parts of the world but are apparently more numerous in the temperate regions. The adult flies seem to be closely related, but the immature stages are so varied in structure as to make it appear that the group must be a heterogeneous one and the similarity of the adults a result of convergent evolution.

The adult flies may be found resting on rank vegetation. Several of the species (*Limnophila ultima*, for example) swarm in small groups of from fifty to sixty individuals, copulation taking place in the air, as is discussed more fully on page 711.

The immature stages of several species have been made known, but here are still very considerable gaps in the present knowledge. The larvae are among the most carnivorous of all crane-fly larvae. The feeble chitinization of the mental region allows for great distention, and oftentimes the prey of these larvae consists of forms that are nearly as large as the captors themselves.

The data regarding extra-American species may be summarized as follows:

Limnophila bryobia Mik (1881:205–206) was reared from moss, taken in the Auckland Islands, near New Zealand, in the summer (December to February) of 1874–75. The moss was dried and then placed in a temperature of from 12° to 15° Réaumur. In March of 1879 an adult fly appeared. This long interval of more than four years was supposed by Mik to have been passed by the insect as a larva, the dry moss furnishing the food. Possibly the eggs were carried over for a long period before hatching.

Limnophila sinistra Hutton, of New Zealand, has been discussed in some detail by Hudson (1920:33–34), who states that this species is common in most dense forests thruout the country. The larva inhabits fallen tree-trunks in an advanced state of decay, forming burrows between the soft, decayed part and the harder part of the wood. It is about 25 millimeters in length, cylindrical, tapering toward the head, which is very small, and furnished with two minute jaws and a pair of very short antennae. There are eleven visible body segments. The extremity of the last segment is truncate and deeply excavated, the concavity being protected by five converging spines, which can be spread out or drawn inward at the will of the insect. Pedal warts occur on the undersides of all the segments except the three immediately following the head and the terminal segment. The pupa is about 12 millimeters in length, and rather stout. The breathing horns are about one-third the length of the wing sheaths, and are moderately stout and strongly recurved. There are two dorsal rows of hooks on each exposed abdominal segment and one ventral row near the terminal extremity. The valves of the ovipositor are strongly recurved and very stout. The head and the thorax are dark brownish black, highly polished; the abdomen is grayish ocherous, darker in the middle; the ovipositor and the terminal segments of the posterior tarsi are reddish. The pupa rests in a burrow made by the larva near the surface of the log.

Edwards has decided that this insect and a few related species should b placed in a new genus. The affinities of the fly, to judge from the detail supplied by Hudson, are with the Epiphragmaria rather than with th Limnophilaria, but until more details are forthcoming it cannot be defi nitely referred to that division.

Limnophila (*Phylidorea*) *ferruginea* (Meig.), of Europe, is closely allie to *L. adusta* (page 867), and is of especial interest as being the type o the subgenus Phylidorea. It was reared by De Meijere (1916:204–20 from larvae found living between saturated decaying leaves along th banks of watercourses. Further mention of the species is made unde the discussion of the subgenus Phylidorea (page 866).

Limnophila hyalipennis (Zett.), of Europe, was found by Beling (1886 198–199) in piny woods, where the larvae live in old ant hills or in pile of earth thrown up by wagon wheels. The apparent lack of pupal breathin horns in this species is discussed on page 755. The European specie *L. lineola* (Meig.) (Beling, 1879:54 and 1886:199–200), *L. nemorali* (Meig.) (Beling, 1886:200–201), and *L. ochracea* (Meig.) (Beling, 1886 202) are all found in damp earth along the margins of woodland stream or in damp spots in the woods. Larvae of *L. dispar* (Meig.) were foun by Perris (1849:331) living in the hard, withered stalks of an umbellifer *Angelica sylvestris* Linn., where they hollowed out long passages in th pith. (This reference is cited by Mik, 1881:204, and by Osten Sacken 1869:201–202.) *Limnophila pallida* Bel. was reared by Beling (1873a 557) from larvae living in a decaying ash trunk.

The reference to *Limnophila platyptera* Macq. given by Heeger (1854 is considered by Osten Sacken (1869:4, 202) to refer to a mycetophilid probably Bolitophila.

The American species that are now known are considered in th following pages. In addition, *Limnophila unica* O. S. has been bred fro larvae found in decaying wood.

It is very probable that some of the species listed above, as well a many of the limnophiline forms that are still unknown as regards thei immature stages, will be found to belong to some one or other of th remaining divisions of the tribe, rather than to the Limnophilaria as her restricted. This group requires more careful study than does any othe division of crane-flies.

ıbgenus **Dicranophragma** Osten Sacken)

1859 *Dicranophragma* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

arva.— Form short and stout. Spiracular disk surrounded by five short lobes, the tral pair the longest, the dorsal lobe very blunt; disk surrounded by a fringe of delicate s which are longest at tips of lobes. Head capsule of the hexatomine type. Mandible erful, prolonged into a strong hook with a large acute tooth just beyond midlength. xilla very long and slender. Mentum chitinized, consisting of a narrow transverse bar ch is ribbed with fine parallel grooves.

Pupa.— Cephalic crest prominent, each half with three setae. Pronotal breathing horns rt, cylindrical, or slightly narrowed to a blunt tip. Mesonotum convex, unarmed. g sheaths short, broad, ending before tip of second abdominal segment. Leg sheaths derate in length, ending just beyond base of fourth abdominal segment, hind tarsi a little ger than the others. Abdominal segments divided into two rings; posterior ring with ıbterminal transverse armature, on dorsum consisting of numerous setiferous tubercles, pleura consisting of two or three groups of setiferous tubercles; basal ring with about t slender tubercles on dorsal surface. Spiracles present, but evidently nonfunctional. sum of segment 8 with four slender tubercles.

Dicranophragma is a well-defined group of the genus Limnophila, with ut six known species whose center of distribution seems to be in the ental region. The type of the subgenus, *Limnophila* (*Dicranophragma*) *covaria*, discussed in detail below, is the only described New World n. The immature stages are spent in rich organic mud in cool, ded woods.

nophila (*Dicranophragma*) *fuscovaria* O. S.

1859 *Limnophila* (*Dicranophragma*) *fuscovaria* O. S. Proc. Acad. Nat. Sci. Phila., p. 240.

The adult flies of *Limnophila fuscovaria* may be easily distinguished by ir broad, heavily spotted wings and the strong supernumerary crossvein cell R_2. They may be swept from rank vegetation in cool, shaded ods. The larva has the body stouter and less elongate than is usual his group of species, but it possesses the same snakelike movements ts near relatives. The pupal duration is not longer than eight days ne 8 to 16, in 1917).

rva.— Length, 6.8–7.2 mm.
Diameter, 0.7–0.8 mm

loration light golden-yellow; maxillary lobes yellow; spiracular disk lined with dark brown. ody rather short and stout, not of the exceedingly elongate type of the Eriopterini, gradu- narrowed to anterior end (Plate XLII, 190); prothoracic segment truncated anteriorly;

when head is retracted, tips of maxillae projecting from prothoracic orifice. Seventh abdominal segment with a transverse fringe of stiff hairs on the sides, these directed laterad and slightly caudad. Body noticeably constricted just before last segment. Spiracular disk (Plate XLII, 195) surrounded by five lobes, and in superficial appearance decidedly eriopterine rather than hexatomine; ventral lobes the longest but still much shorter than is usual in this tribe, slightly divergent, inner face with a double, V-shaped, dark brown mark, inner arm of V narrow, outer arm more expanded, especially at proximal ends, one large inner and two smaller outer sensory bristles at apex of V; lateral lobes narrow, with a V-shaped mark similar to that of ventral lobes but narrower and darker; dorsal lobe broad, the inner face indistinctly lined with parallel, dusky, longitudinal stripes; all five lobes surrounded by a fringe of long, delicate hairs lying just outside brown marks, these hairs longest at tips of lobes and continuous around disk. Spiracles circular, rather widely separated; ring broad, light yellow, narrowly margined outwardly with black. Anal gills four, short and stout.

Head capsule (Plate XLII, 191) very dissected, consisting of six elongate slender plates, three on either side, articulating at a point laterad of mental plate. Labrum (Plate XLII, 192) large; anterior margin indistinctly trilobed, the median lobe hairy; on the ventral, or epipharyngeal, surface, on either side, a slender cylindrical papilla, subhyaline, directed cephalad; sides of epipharynx with a tuft of long setae. Mentum chitinized, consisting of two lateral rods and an anterior transverse bar which is finely ribbed with parallel lines. Immediately dorsad of mentum two roughened papillae (prementum) directed cephalad; esophagus retrorsely roughened. Antenna (Plate XLII, 193) stout, in caustic-potash preparations almost hyaline, tipped with an elongate cylindrical lobe distad of which is a small setiferous tubercle with two long, delicate setae exceeding antennae in length. Mandible (Plate XLII, 194) powerful, very deep at base, produced into an acute, strongly curved tip just beyond midlength a very large, acute tooth which is about one-third length of apical point, in its angle a small, hyaline, flattened, leaflike blade with a truncated apex; basad of large tooth two or three gradually smaller teeth. Maxilla with outer lobes stout, broad at base, gradually narrowed to tip, which is cut off by a constriction into a semi-oval structure; palpi on inner dorsal face of maxillary lobe at about midlength, short, semi-globular, with abundant sensory papillae; when head is completely retracted, the long, pale, slightly divergent tips of maxillary lobes projecting from orifice.

Pupa.— Length of cast skin, about 6 mm.

General coloration dark brown; pronotal breathing horns almost black, with apical fourth conspicuously light yellow; abdominal incisures pale.

Cephalic crest large and prominent, with three long setae on outer face. Labrum blunt at apex. Labial lobes with a blunt point on either side, these directed proximad and caudad. Maxillary palpi broad at base, suddenly narrowed to the long, cylindrical tip, which is darkened. Antennae rather short. Pronotal breathing horns (Plate XLIII, 196) stout, short, almost straight, broad basally, tapering gradually to the blunt tips. Wing sheath very short and broad, ending before tip of second abdominal segment. Leg sheaths short, extending to just beyond base of fourth abdominal segment; all the tarsi ending about on level, or outer sheaths a little the longer.

Abdominal segments (Plate XLIII, 198) each divided into two rings by a false constriction, al ring about two-thirds length of posterior ring. Basal ring on dorsum with a transverse of about eight slender, blunt tubercles before caudal margin; on pleura a similar but ger tubercle opposite basal ring, this tipped with a long, delicate seta. Sternum unarmed. sterior ring on dorsum with a subterminal row of blunt tubercles, simple or bifid, often proximated or crowded, bearing one or two long setae; near base of tergum, opposite racle, a setiferous tubercle; on pleura, opposite base of posterior ring and nearer dorsum n sternum, a vestigial spiracle with a double setiferous tubercle ventrad of it; near caudal rgin of pleura two or three compound multisetose tubercles (Plate XLIII, 197) or aggre- ions of simple tubercles, which are largest on seventh segment. On sternum, two slender ercles on either side, near base of posterior ring. Female cauda (Plate XLIII, 201) ngate, with the tergal valves a little longer than the sternal valves; each of tergal valves h a small tubercle at base. Male cauda (Plate XLIII, 199 and 200) with the ventral es blunt, the dorsal lobes a little longer and ending in an acute point; a tiny tubercle either side at base of dorsal lobes. Dorsum of segment 8 with a trapezoid of four con- uous lobes ending in truncated tubercles; anterior pair of lobes smaller and a little more ely separated than posterior pair.

Nepionotype.— Ithaca, New York.
Neanotype.— Ithaca, New York, May 31, 1917. No. 57–1917.
Paratypes.— Pupal skins, June 11, 1917 (No. 99-1917), June 16, 1917 (No. 132-1917). Abundant larvae, with nepionotype.

ubgenus **Lasiomastix** Osten Sacken)

1859 *Lasiomastix* O. S. Proc. Acad. Nat. Sci. Phila., p. 233.

arva.— Body slender, with pencils of stiff setae on lateral margins of thorax. Spiracular with four lobes, the ventral pair a little the longer and bearing a fringe of long, delicate s, these about twice length of lobes. Anal gills short and stout. Head capsule of atomine type. Mandible powerful, cutting edge with a single row of three or four ened, bladelike teeth. Maxilla very long and slender. Antenna elongate, at tip with nall elongate-oval papilla whose surface is delicately sculptured. Mentum chitinized, rong transverse bar which is ribbed with fine parallel grooves.

Pupa.— Cephalic crest very small, inconspicuous, bilobed. Pronotal breathing horns rt, broad, somewhat compressed, a little pointed at apex. Mesonotum unarmed. dominal segments depressed, armed with numerous tubercles or small spines, these being t abundant on posterior annuli of segments.

The subgenus Lasiomastix includes but six known species, three of ich are from eastern North America. *Limnophila* (*Lasiomastix*) *crocera* is common and widely distributed thruout the Eastern States. (*L.*) *tenuicornis* O. S. and *L.* (*L.*) *subtenuicornis* (Alex.) are found only the Northeastern States and are more local in their distribution. The nature stages of *L.* (*L.*) *macrocera* are spent in rich organic mud. They very similar to those of the subgenus Phylidorea.

Limnophila (*Lasiomastix*) *macrocera* (Say)

1823 *Limnobia macrocera* Say. Journ. Acad. Nat. Sci Phila., vol. 3, p. 20.

Limnophila macrocera is a common swamp-inhabiting crane-fly, the larvae living in organic mud. At Orono, Maine, the writer found larvae of this species associated with larvae of *Bittacomorpha clavipes*, *Pilaria tenuipes*, *P. recondita*, *Erioptera chlorophylla*, and other crane-flies, as well as with leeches, snails, worms of many kinds, and other forms of life. The larva is similar to that of other related species. When placed in water it is very active and has the habit of darting the anterior quarter of its body from one side to the other, suggesting the striking of a reptile. The pupal duration is not more than eight days (June 24 to July 2, June 28 to July 6).

Larva.— Length, 14.5–15 mm.
Diameter, 1.4 mm.

Coloration, pale yellowish white.

Body terete, narrowed toward both ends but more noticeably toward anterior end. Integument covered with a dense appressed pubescence. Chaetotaxy as follows: two stout setae on both dorsal and ventral margins of prothoracic orifice; thorax with pencils of stiff setae near anterior margins of segments, two large lateral tufts and a smaller ventral pair; abdominal segments with a pencil of similar bristles on ventro-lateral margins, one on anterior half, the other midlength, of each ring; a seta at posterior lateral angles of sternites; four setae in a transverse row near posterior margin of tergites, the lateral pair the larger; lateral margins of cauda near base of lateral lobes and above gills with pencils of blackish setae; basal part of segments on both sternum and tergum with transverse parallel rows of fine scabrous points, this area very narrow on second abdominal segment, consisting only of three or four rows, the areas gradually becoming broader and the rows more numerous, there being on sixth and seventh segments about 28 to 30 rows which occupy nearly the basal third of segments.

Spiracular disk (Plate XLIV, 208) surrounded by four lobes; ventral pair the longest, lateral pair a little shorter; ventral lobes near tips with a brush of delicate, exceedingly long hairs which curl into loops at tips, the longest of these hairs about twice length of lobes bearing them; this fringe of hairs continuous around disk, longest at ends of lobes, gradually shortened toward their bases but not interrupted; lateral lobes with terminal hairs a little shorter but still longer than lobes themselves; inner faces of lobes delicately margined with dark brown, those of ventral lobes having the outer lateral margins the broadest. Spiracles rather small, located at base of lateral lobes. Anal gills four, very stout and plump.

Head capsule with a framework of long, slender plates, as is usual in this group. Labrum (Plate XLIV, 205) broadly transverse; anterior margin irregularly rounded; anterior median area truncated, with the lateral angles slightly projecting, cut off squarely, each with a small hyaline, sensory papilla; laterad and caudad of each, two sensory papillae, the innermost elongate-cylindrical, more than twice length of short, oval, outer one. Epipharyngeal

n roughened by tiny groups of parallel ridges. Mental region consisting of a heavily nized transverse bar which is delicately grooved, enlarged at ends, and articulating with all ventral bar. Antenna (Plate XLIV, 206) long and slender; basal segment short and d; second segment elongate-cylindrical, bearing at its tip a small, hyaline, sensory papilla h appears delicately crosshatched by fine impressed lines, this papilla elongate-oval the apex broadly rounded; a long hair near base of this papilla and about twice its length. dible (Plate XLIV, 207) long and powerful, the tip produced into a slender point, the ng edge at about midlength with a single row of three or four flattened, bladelike teeth h are truncated at their tips, these teeth varying considerably in their shape and relative ortions. Maxilla with outer lobe elongate, the base strongly chitinized, this chitinized continuing up margin of lobe almost to tip, the apical part nearly hyaline; at about ength, the small palpus and a long seta. Esophagus enlarged, the walls thickened and hened.

slide of a larva that was supposed to belong to this species differs considerably from naterial described above. The antenna is much shorter, with the apical tubercle much r and elongate-cylindrical; the mandible has the teeth fewer and more acute, quite own by De Meijere for *Limnophila* [*Phylidorea*] *ferruginea*. It is probable that this es likewise is a Phylidorea.)

upa.— Length, 14–16 mm.
Width, d.-s., 1.8–2 mm.
Depth, d.-v., 1.9–2.2 mm.

eathing horns pale whitish brown, a little darker at base; remainder of body dark nish black, abdomen a little lighter-colored; incisures of segments, and pleural line, pale. phalic crest very small, inconspicuous, bilobed, each principal lobe subdivided into smaller lobes terminating in a small seta; another seta on anterior face. Labrum r blunt and truncated at apex. Labial lobes terminating in sharp points projecting mad. Maxillary palpi short and stout, tapering to blunt tips (Plate XLV, 210). na of male elongate, reaching to beyond midlength of wing sheath; antenna of female , ending at about one-fourth length of wing sheath. Segments of antenna cylindrical, ned.

onotal breathing horns (Plate XLV, 209) short, broad, somewhat compressed, a little ed at tip. Thorax broad and deep, the pronotum flattened, carinate medially. notum high, convex, transversely wrinkled. Wing sheaths ending some distance before second abdominal segment. Leg sheaths short, ending before tip of third abdominal ent, the hind legs a little longer than the other legs, which end about on a common

domen depressed, lateral margin carinate. Abdominal segments distinct, incised, each ent divided into two annuli, basal one about half length of posterior one. Basal ring rsum with a transverse single, or somewhat double, row of small subacute spines, which nore numerous and larger on mid-dorsal area. Pleura unarmed. Sternum with an ne flattened lobe or wing on each side, directed caudad and proximad; between these a more or less broken transverse row of from six to twelve slender tubercles. Posterior on dorsum with numerous small scattered tubercles. Pleura with a small circular le near base and close to dorsal margin; a slender seta near spiracle and ventrad of it;

two other setae caudad of spiracle; at caudal margin a solitary seta close to ventral margi
Sternum with scattered slender tubercles, on segment 3 these appearing as a longitudinal ro
of about ten alongside the hind legs; between this lateral longitudinal row and the scatter
discal tubercles, a bare space, at anterior end of which is a large, stout, setiferous tubercl
a subterminal transverse row of about fifteen acute black spines; on terminal segments t
lateral longitudinal rows interrupted, or, on the seventh segment, lacking, on seventh segme
the subterminal armature of both dorsum and sternum more powerful, especially the inte
mediate spines of sternum, which are very large; numerous setae scattered along ro
Segments 3 to 8 on ventral surface of posterior ring with a circular disklike area, medi
in position and at about two-thirds length of ring. (In some specimens, especially female
the discal tubercles on the posterior ring are much smaller and lie in longitudinal rows
Male cauda (Plate XLV, 211) with tergal valves slender, elongate, slightly divergent, tap
ing to the acute tips, which bear a small subterminal seta; sternal valves short, blunt, wi
a flattened oval lobe between valves of sternum; eighth segment on dorsum with a trapezo
of four very long, slender, pointed lobes, which are provided with delicate hairs, the posteri
pair of lobes longer, stouter, and lying closer together; just above anterior pair of lobes
blunt setiferous tubercle; pleural region of segment 8 with two spines; a small seta cephala
of these spines; sternal region of segment 8 with two widely separated setiferous tubercle
Female cauda (Plate XLV, 212) with tergal valves elongate, narrowed at tips, and arme
with sharp, black spines; a few small setae before tips; sternal valves short, blunt, narrowe
at tips.

Nepionotype.— Orono, Maine, July 19, 1913.
Neanotype.— With type larva, July 17, 1913.
Paratypes.— Larvae, with type larva, June 13 to July 27, 1913. Pupae, June 9 to July 2
1913.

(Subgenus **Phylidorea** Bigot)

1854 *Phylidorea* Bigot. Ann. Soc. Ent. France, p. 456.

The immature stages of the type species of Phylidorea, *Limnophil*
(*Phylidorea*) *ferruginea* (Meig.), were described by De Meijere (1916
204–206). In Holland, larvae were found in April on the banks of a ditch
where they were living between decaying leaves. The larvae are cylin
drical, and are from brownish yellow to brown in color. The antenna
are described as three-segmented, the apical papilla being considere
as a segment. The labrum bears on the epipharyngeal surface a media
projection provided with two conspicuous biarticulate lobes. The outer
lobes of the maxillae project as flattened blades. The mandibles ar
powerful and strongly curved, and have a group of small lateral teet
at about midlength.

The pupa is about 10 millimeters long and is blackish brown in colo
The pronotal breathing horns are almost semicircular and are yellowis

vn in color. The abdomen is depressed, with sharp lateral margins. abdominal armature is described as consisting of small hairs instead ender spines as in the American species of this subgenus.

n the Nearctic fauna, the subgenus Phylidorea includes *Limnophila sta*, *L. similis* Alex., *L. novae-angliae* Alex., *L. lutea* Doane, *L. terrae-ie* Alex., *L. costata* Coq., *L. fulvocostalis* Coq., *L. insularis* Johns., and obably other western species. It seems quite possible, moreover, that species allied to *Limnophila lenta* O. S. also belong here.

nophila (*Phylidorea*) *adusta* O. S. (supposition)

1859 *Limnophila adusta* O. S. Proc. Acad. Nat. Sci. Phila., p. 235.

larva of a crane-fly that is almost certainly a member of this genus taken at Ithaca, New York, on May 30, 1917, in company with a morpha (No. 88–1917). An unknown pupa was taken in the sedge ciation on the Bool hillside, Ithaca, on June 4, 1917. It was not ed and its identity can only be surmised, but there can be little doubt s relationship with Phylidorea.

va.— Length, 8.6–9 mm.
Diameter, 0.8 mm.

loration a deep saturated orange-yellow, the body with silky iridescent reflections. dy a little narrowed at both ends. Integument with a long, appressed, golden scence. Numerous long setae and pencils of hairs on body, usually at about midlength on posterior half of, the segments; posterior margin of each segment elevated into a inent transverse ridge of hairs. Spiracular disk surrounded by four lobes, ventral bout twice length of lateral pair; ventral lobes with a rather narrow, dark brown line ner face; outer margin fringed with very long dark hairs which are somewhat paler ir bases, this fringe of hairs longest at tips of lobes, where it reaches a length of about or ten times length of lobe; hairs shorter toward base of lobe; a stiff sensory bristle ter face of lobe, rather far back from tip; lateral lobes similar, with the fringe of hairs r and about twice length of lobes. Spiracles of medium size, directed toward each other. gills four, fleshy, pale in color, posterior pair longer than anterior pair.

ad capsule of hexatomine type, the dorsal plates narrowly interrupted on mid-dorsal behind clypeal-labral sclerite. Labrum very large, anterior margin provided with or ten papillae and setae. Epipharyngeal region having a large, median, circular which is slightly elevated and bears two bisegmented cylindrical papillae. Mental as usual in the genus, consisting of three hinged bars forming three sides of a rectangle, nterior transverse bar delicately grooved. Antenna two-segmented, second segment wer than first and bearing at its tip an elongate sculptured papilla and a long seta. ible of hexatomine type, a powerful curved hook, at about midlength of which is an

acute tooth; in axil of latter a small flattened blade which is slightly widened outwardly an has the tip truncated. Maxillary lobe broad at base, tapering to narrow tip.

Pupa.— Length, 12 mm.
Depth, d.-v., 1.6 mm.

Similar to *Limnophila macrocera* in general shape and color, differing as follows:

Labrum broadly obtuse at tip. Pronotal breathing horns (Plate XLIII, 203) very shor stout but flattened, constricted beyond midlength, and with a row of breathing pores aroun apex; pronotum and mesonotum carinate medially in front; wing pad showing venation rath clearly, cell M_1 deep, basal deflection of Cu_1 beyond midlength of cell *1st* M_2. Abdomin segments with lateral margins very deeply incised, the carinate lateral margins very accentu ated, appearing as thin, flattened wings (Plate XLIII, 204). Armature of abdomen consist ing of abundant elongate, acicular spines, some of which are sinuously twisted; on basal rin these spines appearing as a subterminal transverse row on both dorsum and sternum; o posterior ring, besides the subterminal transverse row, spines are scattered over surface i more or less distinct longitudinal rows; at lateral carina a group of about a dozen long spine at caudal margin, as well as a powerful spine below level of spiracle on extreme margin o carina; ventrad and caudad of this, three long setae, two close beneath spine and the thir underneath spiracle. Female cauda (Plate XLIII, 202) about as in *Limnophila macrocera* but sternal valves divergent at their tips; eighth segment with a trapezoid of dorsal lobe about as in *L. macrocera*, but sternum with four stout spines bearing setae on their sides a blunt median lobe near base of eighth sternite.

(Described from a female pupa taken on Bool's hillside, Ithaca, New York, on June 4 1917, where it was associated with a characteristic swamp-inhabiting crane-fly fauna — *Bittacomorpha clavipes*, *Pseudolimnophila luteipennis*, *Limnophila macrocera*, *Pilaria recondita* and *Prionocera fuscipennis*.)

(Subgenus **Limnophila** Macquart)

1834 *Limnophila* Macq. Suit. à Buff., vol. 1, Hist. Nat. Ins., Dipt., p. 95.
1863 *Poecilostola* Schin. Dipt. Austriaca, vol. 2, p. 551.

Limnophila is the typical subgenus of the group, the type having been designated as *Limnophila pictipennis* by Westwood in 1840. No species of this subgenus have yet been described from North America.

The larva of *L. punctata* (Meig.) was described by Beling (1886:195–197) and by Gerbig (1913:158–161) as living in wet earth, by Scheffer (1848:10) and by Cameron (1917:63) as living in decaying wood. Gerbig found larvae in sandy soil near both standing and flowing water. The larvae are very active, are rust-brown in color, and attain a length of 15 millimeters with a diameter of from 1.5 to 2 millimeters. The body is provided with several setae and setiferous projections. The spiracular disk (Plate XLVI, 214) is surrounded by four subequal lobes and an additional reduced dorso-median lobe; all of these lobes are fringed with long

rs, and each of the four paired lobes has a sensory bristle near the tip. e four anal gills are not very prominent.

The head capsule is of the hexatomine type. The mandibles are kle-shaped, with two small, broad, blunt, sawlike teeth just beyond dlength.

Brauer (1883:55) found the larvae of another species — *L. pictipennis* Ieig.), the type of the genus — between wet decaying leaves in bogs. s figure of the head capsule (1883, pl. 1, fig. 10) shows a typical hexa- mine head (Plate XLVI, 213). Beling (1879:51–52) found this species the sand of a small, dried-out brook bed.

oup Ulomorphae

nus Ulomorpha Osten Sacken (Gr. *Ula* + *shape*)

1869 *Ulomorpha* O. S. Mon. Dipt. N. Amer., part 4, p. 232.

arva.— Form slender. Body covered with a rich golden-yellow pubescence. Spiracular surrounded by four unequal lobes, the ventral pair the longest, lying subparallel, fringed n exceedingly elongate hairs. Spiracles small. Head capsule narrow, the dorsal plate row, at tip expanded into a spatula. Mandible hinged, blade very long and slender, n a single very long lateral tooth at its base. Maxilla densely golden hairy, outer lobe ecting, bladelike. Antenna with a very long, tapering, apical papilla. Mentum not inized.

Pupa.— Cephalic crest prominent, each lobe with three setae. Pronotal breathing horns long and slender, sinuous, cylindrical, at apex split into two flattened divergent lobes. conotum short, very convex, unarmed. Wing sheaths attaining end of second abdominal nent. Leg sheaths short, ending before tip of third abdominal segment; hind tarsi ttle longer than the others. Abdominal segments divided into two rings, posterior ring n a subterminal transverse armature of stout black spines and a few long setae; sternal ature stronger than that of dorsum. Pleura armed with a few similar spines. Acido- ae of ovipositor very long and slender. Dorsum of segment 8 with a trapezoid of four s.

The genus Ulomorpha includes five known species, the genotype, *omorpha pilosella*, of the eastern United States, and four western rth American species. The immature stages of the genotype are spent ich organic mud in shaded situations.

omorpha pilosella (O. S.)

1859 *Limnophila pilosella* O. S. Proc. Acad. Nat. Sci. Phila., p. 242.

Ulomorpha pilosella is not uncommon in cool Canadian woods thruout theastern North America, and the adult flies may be swept from

rank vegetation in such haunts. The flies bear a marked resemblan to the species of the subgenus Lasiomastix of the genus Limnophila, h the pupae, especially in the structure of the pronotal breathing hor are quite distinct. The larvae are different from the related and som what similar larvae of the subgenus Dicranophragma of the genus Li nophila, of Penthoptera, and of similar hexatomine genera, in their p whitish yellow coloration instead of the deep saturated yellows and oran of the genera mentioned. All, however, have the quick, restless mo ments so characteristic of this group of crane-flies. Larvae found Bool's hillside, Ithaca, New York, on May 14 and 23, 1917, transform to adults on June 9.

Larva.— Length, 8.5–9 mm.
Diameter, 0.5–0.6 mm.

Coloration pale whitish yellow, the eighth abdominal segment suddenly whitish.

Form slender. Body covered with a dense golden-yellow pubescence. A transverse frin of stiff, erect, short hairs at posterior margin of prothorax. A number of pencils of se or solitary bristles on sides of segments, one on each annulus, longest near posterior marg of segments. Behind these setae, tufts of small hairs. Spiracular disk (Plate XL 219) surrounded by four lobes; ventral pair the longest, lying subparallel to each oth outer margin fringed with long, delicate hairs, those near tip coarse and easily broken, so of the hairs at tips exceedingly elongate; inner face of ventral lobes heavily suffused with da brown, this color more intense proximally; lateral lobes short, with an apical fringe of co yellowish setae. Spiracles very small, widely separated, located at base of lateral lob Anal gills four, very slender, pale in color, the posterior pair a little the longer. On stern of eighth abdominal segment, before gills, a transverse row of four long, coarse setae.

Head capsule (Plate XLVI, 215) very long and narrow, the dorsal plate slender, at e expanded into a spatula; lateral plates a little shorter than dorsal plate. Labrum (Pl XLVI, 216) and epipharynx broadly transverse, projecting, the anterior margin narrow truncated, on either side near base with a brush of long hairs; disk of epipharyngeal reg with four setae, posterior pair a little the closer together; a few tiny papillae on ven surface; clypeal region emarginate, with two large setae near anterior margin and anot immediately behind base of antenna. Mental region not readily distinguishable in material available, but at the most with little or no chitinization. Antenna (Plate XL 217) with basal segment cylindrical, a little narrowed medially, the truncated apex with ab two or three long setae and a very long, hyaline, sensory papilla which tapers gradually apex, this papilla about three times length of segment bearing it. Mandible (Plate XL 218) hinged, the base slender but powerful, with the inner face deeply concave to rece mandible in a position of rest; blade of mandible produced into a very slender hook wh is almost straight, a little curved at extreme tip, at its base a very large, acute, flatte blade which is more than half length of mandible itself; in its angle this blade has a seco microscopic, tooth; prostheca with about five long, stout, comblike teeth exceeding mandible in length, and an additional shorter, flattened blade marked with parallel groo

es. Maxilla with dense tufts of long yellow hairs; outer lobe produced cephalad as a line, flattened blade which projects from prothoracic orifice when head is retracted.

Pupa.— Length, 8.5–9 mm.
Length of pronotal breathing horns, nearly 2 mm.
Width, d.-s., 1 mm.
Depth, d.-v., 1 mm.

Head, thorax, and appendages dark brown; pronotal breathing horns similar, but terminal f gradually paler, the tip almost yellow; abdomen pale brown.

Cephalic crest consisting of two prominent lobes, each with three strong setae, the most tral directed outward; just before primary crest and lying between antennal bases, a very , slightly bilobed crest which is not setiferous. Labrum elongate, obtusely rounded at x and separating labial lobes, the latter produced caudally into subacute points. Maxillary pi stout at base, narrowed to tip (Plate XLVII, 221). Antenna short (in female sex, at t), extending but a short distance beyond knee joints of fore legs. Pronotum (Plate VII, 220) high, feebly carinate medially. Breathing horns separated basally, very long slender, sinuous, transversely wrinkled, at tip split into two flattened divergent lobes ate XLVII, 222 and 223). Mesonotum very short and convex, with numerous black dots ch are most abundant anteriorly. Two small setae on either side behind wing axilla. eral angles of mesonotum blunt, but tip produced into a slender setiferous tubercle. g sheaths ending opposite tip of second abdominal segment. Leg sheaths short, ending before tip of third abdominal segment, hind legs a little longer than others.

bdomen with a narrow basal ring and a much broader posterior ring, the latter armed re posterior margin with a transverse row of small black spines, strongest on pleura, kest on dorsum; on dorsum (Plate XLVII, 224) the spines reduced in number, there g from one to five (or in some cases none), and occurring only at or near ends of row; s of row with two setae; on either side of median line a group of three closely approxi- ed setae; usually segments 2 and 3 have the spines weak or lacking; segments 4 to 6 two spines, and segment 7 with one spine, but in some specimens the number is slightly eased. Sternites (Plate XLVII, 225) with the intermediate segments (4 to 6) having it twenty spines in an almost continuous row which as a rule is uninterrupted; at end of row about two strong setae; near base of posterior ring a narrow transverse with two setae at each end. Pleura with a few powerful spines, small or lacking on l segments, larger and more numerous on posterior segments, there being usually two segment 4, three on segments 5 and 6, and four on segment 7; on pleura at about mid- th of posterior ring and nearer dorsal side, three black setae in transverse alinement, e somewhat longer on basal segments; opposite basal ring a stout seta. Female cauda te XLVII, 226) elongate; tergal valves slender, slightly upcurved, near apex with a p black spine which is directed dorsad, laterad, and caudad; two weak setae on either before apex. Dorsum of segment 8 with four lobes; posterior pair elongate, slender, ed, and divergent; anterior pair blunt, small, and more approximated; just ventrad of e lobes a stout seta; pleural region with two powerful spines, above the more dorsal hich is a stout seta; a seta near ventral margin.

Lepionotype.— Ithaca, New York, May 30, 1917. No. 88–1917.
Allotype.— With type larva, reared June 9, 1917.
Paratypes.— Larvae, May 30, 1917. Pupa, June 13, 1917.

Genus **Pilaria** Sintenis (Lat., derived from *the long antennal verticils*)

1888 *Pilaria* Sintenis. Sitzber. Nat.-Ges. Dorpat., vol. 8, p. 398.
1919 *Eulimnophila* Alex. Cornell Univ. Agr. Exp. Sta., Mem. 25, p. 917.

Larva.— Form moderately slender. Spiracular disk surrounded by four unequal l lateral pair in some cases very reduced, elongate ventral lobes fringed with long hairs. H capsule of Ulomorpha type. Mandible hinged, blade with one or two acute teeth at Maxilla densely hairy. Mentum not chitinized.

Pupa.— Pronotal breathing horns elongate-cylindrical, tips split into flattened l Abdominal segments with three or four pairs of naked tubercles.

The genus Pilaria includes a group of species of the old genus Limnop comprising *Limnophila tenuipes* and *L. pilicornis* and their allies. relationships are plainly with Ulomorpha rather than with Limnop The genotype is *Limnophila pilicornis* (Zett.), of northern Europe. O included species are *L. tenuipes*, *L. recondita*, *L. imbecilla* O. S., *L. edw* Alex., *L. quadrata*, *L. stanwoodae* Alex., and *L. osborni* Alex., of N America, and *L. discicollis* (Meig.), *L. fuscipennis* (Meig.), *L. subti* (Zett.), and probably other species, of Europe.

The immature stages are spent in mud or moist earth. In Eur *Pilaria discicollis* (Plate XLVIII, 232) has been found by Gerbig (19 163–164) and by Cameron (1917:63). *P. fuscipennis* is described Beling (1886:197–198) as living in mud near a ditch. Gerbig (1913:1 166) found the larvae (Plate XLVIII, 231) in a similar situation. Bra (1883:54) describes them as living between decaying leaves in swan Cameron (1917:63) states that the larvae are found in decaying v this record possibly being an error. According to Beling, the pupal d tion is not more than ten days. In America, *P. tenuipes* has been cussed by Hart (1898 [1895]:204–205) and by Malloch (1915–17b:2 224), as stated under the discussion of the species.

The species of the genus Pilaria may be separated by the follow keys:

Larvae

Ventral lobes of spiracular disk elongate, heavily marked with brownish black; colors pale yellow..... *P. tenuipes* (Say) (p.
Ventral lobes of spiracular disk short, pale; coloration deep yellow.
P. recondita (O. S.) (p.

Pupae

1. Pronotal breathing horns short, black; lobules of cephalic crest blunt and rounded.
P. quadrata (O. S.) (p.
Pronotal breathing horns elongate, pale, brownish yellow or yellow; lobules of cep crest elongate, finger-like.....

ıtennal sheaths of male elongate; pronotal breathing horns longer, pale yellow.
P. tenuipes (Say) (p. 873)
ıtennal sheaths of male short; pronotal breathing horns shorter, yellowish brown.
P. recondita (O. S.) (p. 874)

ria tenuipes (Say)

1823 *Limnobia tenuipes* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 21.
1869 *Limnophila tenuipes* O. S. Mon. Dipt. N. Amer., part 4, p. 210–211.

ilaria tenuipes is a widely distributed crane-fly thruout eastern North erica. The immature stages are commonly found in the mud of mps, or near streams and other bodies of water. This is the unknown nophila described by Hart (1898 [1895]:204–205), and also considered uch detail by Malloch (1915–17b:223–224), who found the pupae g the banks of the Sangamon River in Illinois.

va.— Length, 16 mm.
Diameter, 1.4–1.5 mm.

oration of living larva, pale brownish yellow. Body covered with a long, dark-colored, ssed pubescence, more conspicuous on posterior segments. Lateral pencils of setae base and apex of segments. Antepenultimate segment of body capable of globular ıtion, covered with numerous transverse rows of microscopic roughened points. cular disk (Plate XLVIII, 230) moderately large, surrounded by four lobes; ventral long and slender, inner face with closely approximated, transverse, brownish black lines cause entire face to appear dark; near tips of lobes these black marks tapering out long point; basal parts of dark marks subcontiguously hollowed out interiorly to form e pale area below spiracles; ventral lobes fringed with long, pale hairs, some of them lingly elongate. Lateral lobes very small, blunt, tending to be reduced, bearing short s of dark hairs. Anal gills slender, pale in color.

ıd capsule of Ulomorpha type and not very different from that of the type genus; plate broad basally, narrowed gradually behind to near tip where it expands into large spatula. Epipharyngeal region of labrum and maxillae fringed with dense tufts rushes of long yellow hairs. Maxillary lobe relatively small but elongate, hyaline, ng to flattened apex. Antenna (Plate XLVIII, 229) with basal segment elongate, g at its tip an elongate apical papilla which is a little longer than the segment, bluntly ed at its tip, and delicately sculptured. Mandible (Plate XLVIII, 228) very long, l, at its base an acute tooth equal in length to about one-third length of mandible; in pe larva, the left mandible a little longer than the right mandible. Mental region ıitinized.

pa.— Length, 10–15 mm.
Width, d.-s., 1.5–1.6 mm.
Depth, d.-v., 1.6–1.8 mm.

oration dark brown; pronotal breathing horns light yellow, extreme bases brownish. halic crest small, composed of three slender, finger-like lobes which are tipped with setae; on front, before crest, two setiferous lobes. Labrum small, bluntly rounded

at apex. Labial lobes oval. Maxillary palpi slender. Antenna of female modera elongated, reaching to just beyond wing root. Pronotal breathing horns (Plate XLIX, elongate, cylindrical, sinuous, transversely wrinkled, apex scarcely enlarged but de split on inner margin; a setiferous tubercle ventrad and laterad of breathing horns. Th with a very high anterior median crest. A slender, setiferous tubercle above wing and two others on either side of median line. Sheaths of halteres long and slender. sheaths ending about on a level, or those of hind legs the shortest and those of fore le little longer.

Abdominal segments divided into two annuli. Tergites (Plate XLIX, 235) on post ring with a caudal row of blunt, naked tubercles; at end of row two setae; on either si median area and just in front of row, a large setiferous tubercle; at base of ring two m tubercles, one on either side of median line; two slender setiferous tubercles near m of ring. Basal ring with four naked tubercles. (The third pair of tubercles found ir pupa of *Pilaria quadrata* is vestigial.) Pleura with four tubercles, two on each ring basal one of each ring setiferous, the posterior one naked. Sternites with six naked tube on basal ring, arranged in three transverse pairs; on posterior ring at base two setife tubercles, each with two bristles, directly behind last naked tubercle of basal ring; at ca margin two or three large tubercles near end of row and about four or five small naked tube between. Female cauda (Plate XLIX, 234 and 236) very elongate, tergal valves sli upcurved, terminating in a sharp spine and with two setae on outer face. Eighth ter with four elongate lobes; posterior pair blunt, directed laterad; anterior pair elongate, slen with two setae laterad of each. A blunt lobe on pleural region. Pleura with three or powerful tubercles, with a seta located between the more dorsal pair. Sternal region four small setae, two on either side of broad median area.

Nepionotype.— Orono, Maine, July 1, 1913. No. 50–1913.
Neanotype.— With type larva.

Pilaria recondita (O. S.)

1869 *Limnophila recondita* O. S. Mon. Dipt. N. Amer., part 4, p. 212–213.

Pilaria recondita is a common crane-fly thruout the northeast United States. The immature stages are swamp inhabitants, and very frequently found in exactly the same situations as are those of *tenuipes*. *P. recondita* belongs to the same group as *P. tenuipes*, and pupae of the two species are very difficult to distinguish.

Larva.— Length, 15 mm.
Diameter, 1.2 mm.

Color a uniform light yellow.

Body covered with a long, appressed, yellow pubescence and with a few long se Spiracular disk very small, in a position of rest almost closed, surrounded by four lo ventral lobes moderately elongated, fringed with long, golden-yellow hairs which are lon at tips of lobes; if bent backward these elongate hairs extending to beyond gills; inner of lobes almost unmarked, with only a delicate brown line extending from tip toward

distance equal to about one-half length of lobes; lateral lobes small, subdorsal in position, rated by a narrow notch, their inner faces opposed to each other, margin fringed with t, golden-yellow hairs. Anal gills four, moderately elongated.

ead capsule as in *P. tenuipes*. Antenna with sculptured apical papilla tapering to t tip; besides this papilla, an even longer, hyaline, flattened blade. Mandible with al bladelike part shorter and stouter, with two subequal stout triangular teeth at base te XLVIII, 227).

upa.— Very similar to pupa of *P. tenuipes*, but smaller. Antennal sheaths of male t. Breathing horns a little shorter than in *P. tenuipes* but still much longer than . *quadrata*, of a pale yellowish brown color. On abdominal tergites, along caudal margin osterior ring, from four to seven naked tubercles between the setiferous tubercles (in *enuipes*, four or five). Male cauda (Plate L, 237) with dorsal lobes stout, cylindrical, owed at tips, divergent, directed caudad and ventrad; on outer face before tip a slender ventral lobes blunt, with a flattened ventral tubercle at base of notch. Segment 8 on im with posterior lobes blunt, straight, directed caudad and slightly laterad, but not so gly as in *P. tenuipes*.

epionotype.— Orono, Maine, July 3, 1913.

eanotype.— Ithaca, New York, emerged June 11, 1917. No. 112–1917.

ratypes.— Pupa, Orono, Maine, placed in rearing as a fully grown larva, June 26, 1913; ged as an adult male, July 3, 1913, showing a pupal duration of seven days. Larva, o, Maine, July 5, 1913 (No. 74–913).

ria quadrata (O. S.)

1859 *Limnophila quadrata* O. S. Proc. Acad. Nat. Sci. Phila., p. 241.

Pilaria quadrata is a widely distributed spring and early summer ies. The immature stages are very similar to those of *P. tenuipes* *P. recondita*. A pupa was found by Dr. Needham in the Indian ng, Ithaca, New York, where it was found floating among the water s. From this pupa an adult female fly was reared. On June 3, 1917, writer found two fully matured male pupae in Chickaree Woods near ca. There had been a very heavy rainstorm on the preceding day, the low spots in the woods had been converted into small ponds, y of the insects that normally live in the mud or beneath the decaying es being forced to the surface. The pupae of *P. quadrata*, as well n abundance of Tipula larvae, were found clinging to small islands débris floating on these temporary woodland pools. The adult flies rged on June 3.

pa.— Length of cast pupal skin, 9–12 mm.

loration almost black, including pronotal breathing horns; abdomen more dusky gray. phalic crest small, black, trilobed, each lobe with a seta at apex. Labrum narrow, at tip. Labial lobes rounded. Sheaths of maxillary palpi elongate, tapering to the

slender points. Antenna short in both sexes. Pronotal breathing horns (Plate L, 2 moderately elongate, cylindrical, transversely wrinkled, at tips smooth, flattened, slightly enlarged. A tubercle with two long setae above wing axil. Two setiferous punct on dorsum on either side of median line. Wing sheaths ending before tip of second abdom segment. Leg sheaths ending before tip of third abdominal segment, the tarsal she ending about on a level or the hind legs shorter.

Abdominal segments with tergites (Plate L, 239) 2 to 6 provided with eight na discal tubercles, arranged in four transverse pairs, the third pair more approximated; lat of third pair of naked tubercles, two small setiferous tubercles; on seventh segment one of four pairs of tubercles lacking; near caudal margin of segments a transverse row of w setiferous tubercles; on either side of median line, in alinement with discal tubercles just anterior to the transverse setiferous row, a large tubercle provided with three s Pleural region carinate, each segment armed with four slightly curved tubercles: ante one solitary, setiferous; second one solitary, naked; third one with two or three setae; poste one bifid, naked. Sternites (Plate L, 240) with six naked, discal tubercles correspon to those of tergites but reduced in number. Subterminal armature weak, ends of r tuberculate; an isolated setiferous tubercle ventrad and laterad of ends of rows. M cauda (Plate L, 242) elongate; dorsal lobes elongate-cylindrical, directed caudad slightly dorsad, tapering to acute tips; three weak setae on outer ventral face; ventral lo blunt, much shorter than dorsal lobes, with a blunt median lobule between them at t base; eighth segment on tergum provided with a large, blunt, median tubercle, with large posterior lobes which are directed caudad and with two tiny lobes on either side front; sternum with a transverse row of four separated setiferous tubercles; caudal mar with a transverse row of about eight or nine pale tubercles on either side, the outermost largest; a small seta above second tubercle at ends of row. Female cauda (Plate 241) very long and slender, subacicular, sternal valves a little shorter than tergal valv tergal valves terminating in blunt cylindrical points.

Neanotype.— Male pupal skin, Ithaca, New York, June 3, 1917.
Paratypes.— Pupa, a male skin with type pupa; a female skin, Ithaca.

Subtribe **Hexatomaria**

The subtribe Hexatomaria comprises a well-defined division with four known genera, three of which are North American and are consider in this paper. The only other group of crane-flies with which the spec may be confused are certain of the Limnophilaria, especially the Ulomorp group of genera.

The larvae have the labral sclerite of the head capsule large, separat from the remainder of the capsule by a distinct suture. The epipharyng region is restricted to the anterior median part of the sclerite, and is p vided with two large tubercles on either side, which are tipped with t or three hyaline, cylindrical papillae. Between these papillae is a bru

airs surrounding two pairs of setiferous tubercles. The mental region ot chitinized. The dorsal plates of the head capsule are widely sepad from each other by a median split.

he pupae are often armed with spines or tubercles on or about the d and the thorax. The lateral abdominal spiracles are large and ctional.

he genera of the subtribe Hexatomaria may be separated by the bwing keys:

Larvae

oloration of body a deep saturated orange-yellow; spiracular disk with ventral lobes unlined with darker, bearing at tips a few very long hairs. . . *Penthoptera* Schin. (p. 891)
oloration of body pale yellow, whitish, or greenish; spiracular disk with lobes lined with dark brown or black 2
ze small, form slender (length 14–15 mm., diameter 1–1.3 mm.) . . *Hexatoma* Latr. (p. 877)
ze larger, form stouter (length over 15 mm., diameter over 1.6 mm.) *Eriocera* Macq. (p. 881)

Pupae

ronotal breathing horns short and stout, red at base and apex, the remaining part dark-colored, transversely wrinkled; horns bent strongly toward each other at tips. *Penthoptera* Schin. (p. 891)
ronotal breathing horns not as above 2
ze small (length under 10 mm.) . . . . . *Hexatoma* Latr. (p. 877)
ze larger (length over 12 mm.) . . . . . *Eriocera* Macq. (p. 881)

us **Hexatoma** Latreille (Gr. *six* + *I cut*)

1809 *Hexatoma* Latr. Gen. Crust. et Ins., vol. 4, p. 260.
1818 *Nematocera* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 209.
1818 *Anisomera* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 210.

rva.— Size small (length of *Hexatoma megacera* about 14 mm.). Spiracular disk surded by two pairs of lobes, ventral pair the longer, inner face marked with a narrow n line which is expanded at its inner end. Head capsule with lateral angles of labrum gate and densely clothed with hairs.

upa.— Size small (length under 10 mm.). A large spinous tubercle on scape of antenna. nedian projection on mesonotal scutellum. Pronotal breathing horns short and straight. g pads with cell R_2 very small and M with but a single branch reaching wing margin.

he genus Hexatoma includes a small number of forms with a chiefly arctic distribution, there being about eleven Palearctic, two Ethiopian, one North American species so far described. The adult flies of North American species, *Hexatoma megacera*, are common on vegetation g the banks of rather large streams. They are discussed herein in il under the account of this species. The adult flies of some of the er European species have habits quite like those of the genus Eriocera,

as discussed elsewhere in this paper (page 705). Riedel (1909:
describes in some detail the habits and swarming of *H. bicolor* (Mei
the males of which are very active in the forenoon during the hours
brightest sunlight, the females resting on the willow branches near
Similar habits are recorded by Riedel (1910:30) for *H. saxonum* (L
The immature stages of the European species are practically unkno
the only original reference being that of Von Röser (1834), who states t
the larvae of *H. nigra* Latr. live in the sand along the banks of stream

Hexatoma megacera (O. S.)

1859 *Anisomera megacera* O. S. Proc. Acad. Nat. Sci. Phila., p. 242.

The adult flies of *Hexatoma megacera* are on the wing during the mon
of May and June and may be swept from the rank vegetation along
streams from which their larvae emerged. The following notes on co
lation, resting positions, egg laying in nature and in captivity, and ot
details, are quoted from published field observations (Alexander, 1915
143–145):

May 14, 1911 — This usually rare insect was common on a grassy plot of land al
Cascadilla Creek [Ithaca, New York]. The flies sit on the blades of grass, the long anten
of the male directed straight ahead. The males are very poor fliers and prefer to drop to
ground when disturbed and clumsily work their way off along the ground. When approac
from the side they are much more easily alarmed and fly away. When approached f
above, they do not move until the stick, finger, or whatnot, is within a couple of inc
when they remove the fore feet from the support and, on nearer approach, fall to the grou
When in copulation, the female tries to disengage by rapidly vibrating the wings in attem
flight, repeating this often, from every one to five seconds until disengaged or exhaus
The male can disconnect himself at will. In copulation the female is always uppern
unless exhausted, when both sexes lie flat on a grass-blade. The female has the head
the male the head downward; copulation always takes place on a vertical support, usu
a blade of grass, sometimes a plant stem. The sexes remain in copulation for quite a l
time and are perfectly motionless. All of the legs of both sexes are on the support un
in a position where this is physically impossible, in which case as many as possible are u
the hind legs of both sexes are held at right angles to the support, the forelegs in front. A
copulation the female generally drops to the ground, the male, after a few moments' rest,
away. Specimens in copulation were found in abundance from 2 to 4.30 p.m. when no n
could be discovered. From 4.30 to 7 p.m. solitary males were common, but no females c
be found on the grass-blades. At 4.30 p.m., a few females were found clinging to the tru
of the willow trees about two feet from the ground. At 5.30 p.m., females were note
small groups over the water, evidently engaged in oviposition, as they frequently dip
down to the surface. These latter were in company with a large swarm of dancing emp
flies (Rhamphomyia). Of the great numbers that were picked from grasses in the a
noon a considerable proportion were females and toward 5 p.m. they commenced egg-la
on the sides of the containing vessel, large shell vials. By 7 p.m. the sides of the vials
black in places with the large, dark-colored eggs. This data would seem to place the
for oviposition at about sunset. The females are very good fliers and often travel for

ıces before alighting as is shown toward sunset when they fly for long stretches up-
n. The males are rather poor fliers, due in part, possibly, to the weight of the long
nae and, as stated before, this sex prefers to skulk rather than fly. When the males
ıey do so heavily and seize the first support that they collide with and hang on, occasion-
ying on immediately to another support. When the male comes in contact with a stem,
ry often ascends to the top by means of a part-flying, part-climbing motion and, on reach-
e summit, flies off to another place. As a rule the flies, especially the females, alight on
le grassblade, but very often the males are observed on two blades, the legs of one side
e blade and those of the opposite side on the other; when the body thus hangs between
alks, the tarsi diverge from one another, whereas on a single support, the legs converge.
xatoma was preyed upon by large numbers of a scatophagid fly that occurred in great
dance in this vicinity and seemed to be subsisting almost entirely on these flies. At
twenty of these predaceous flies were noted with Hexatomae and this species seemed
nstitute the principle insect enemy of the crane-fly. They would lurk on the grass
s and sally forth after their prey, carrying it back to some point to feed upon it. It is
ble that the blood is taken since the body of the Hexatoma appeared almost uninjured
examined. On an old beam where males had a habit of walking up the vertical face,
ll spider's web was found, in which eleven specimens were entangled, two being still
eight of these were males, the remaining three, females.
e males especially can walk up smooth surfaces, as glass, moving the legs alternately
wkwardly. The first pair taken were in copulation but in placing them in the vial
ıecame disengaged and ran about in the container. After a short time they began to.
ate in the tube.
y 15, 1911 — A pair were taken in copulation at 10 a.m.; at 8 p.m. they were still in
but this is exceptional as most of the pairs disengage very readily. In the morning
ıecies is very active and although the males do not fly far, they fly readily and it is
ılt to pick them up by hand. The females are excellent fliers especially in the morning.
eral pairs were taken in copulation and each pair was isolated in a separate vial in order
certain the number of eggs per female. The clutch was determined by dissection.
the captive insects began to oviposit, the eggs shot out from the body, at first slowly,
more rapidly, one per second, later much slower again, the eggs being extruded one at
e. The total period of oviposition required seven minutes; at the end of sixty seconds,
space between sixty and seventy seconds, eighteen eggs were laid, or 1.8 per second.
rd the end of egg-laying, the eggs appeared much more slowly, one in two seconds. The
ıre quite sticky or viscid and adhere to the glass. When the female is in danger of
, as when she falls into the water, she begins, at once, to deposit the egg-complement.
ture it seems probable that one egg is laid at each descent to the water. As soon as
male touches the water, although she has not deposited an egg all day, she immediately
to deposit the oblong black eggs. After the last egg is expelled the muscles of the
itor still go through the motions of expulsion. One specimen was placed in the water
s usual began to deposit her eggs. She was decapitated, laid eleven eggs and tried to
ill more but failed. The number of eggs laid varied from 316 to 372 with an average
; the time required for oviposition varied from seven minutes to seven minutes and forty
ds. In most cases the number of the egg-complement is probably between 300 and 400.

ıe greater part of the larval existence is probably spent in the water, it is only when the larvae are fully grown and ready to pupate that come to land. On April 26, 1914, gravel from the bank of Casca- Creek was carefully examined, but no signs of larvae or pupae were e discovered. On May 6, however, the same bank was examined about ten larvae and seventy-five pupae were found. Sometimes the ature stages are very abundant. On May 12, 1917, near the place

just described, the writer found larvae and newly transformed pupa great numbers, the former pupating in the dry sand rather distant the water's edge. In one dry patch of sand on a rocky ledge, specimens were found in six square inches of soil. The insects are found in gravel or coarse sand that is thickly penetrated by grass and rhizomes, rarely in pure gravel. They are most commonly f in soil that has been recently deposited after freshets. The imm stages of Hexatoma are associated with larvae of *Eriocera spinos cinerea*, *Tipula bella*, and *Atherix* probably *variegata* Walk., with p of *Chrysops excitans* Walk., and with many beetles such as *Pa littorarius* Grav., *Gastrolobium bicolor* (Grav.), *Bledius* sp., *Omophro Dyschirius sphaericollis* Say, *Tachistodes partiarius* (Say), *Anad discoideus* (Dej.), *Laccobius agilis* Rand, and other species characte of the sandy margins of large streams. The pupal duration of Hexa is six and one-half days.

Larva.— Length, 14–15 mm.
Diameter, 1–1.3 mm.

Color of body, pale brownish yellow.

Body covered with rather abundant appressed hairs, the subterminal distended p abdomen with transverse rows of very short spines or setae, there being from thirty- forty such rows. Spiracular disk (Plate LI, 246) surrounded by four lobes; ventra the longer, with a fringe of a few long hairs at apex; on inner face a long, narrow, mark, extending from the tip inward, the proximal end expanded; lateral lobes with nu long hairs which are gradually shorter toward base of lobes. Spiracles circular, situa base of lateral lobes; a dusky mark extending from spiracles dorsad.

Head capsule of usual hexatomine type, as described for *Eriocera longicornis* (page Entire general features and details of mouth parts very similar to those of *Eriocera longi* Labrum (Plate LI, 243) transversely oval, with frame strong and chitinized, anterior m part produced into a small lobe (Plate LII, 250) bearing two lateral papillae and two set tubercles surrounded by short hairs; lateral margins of labrum produced into pro lobes directed proximad and cephalad, densely hairy and entirely protecting anterior m of labrum. Antenna (Plate LI, 244) with apical papillae shorter than segment, the papilla transversely sculptured (Plate LII, 251). Mandible (Plate LI, 245) long an der, the lateral teeth more accentuated than in Eriocera; largest tooth with a flattened cated blade in its axil, this in some cases broken up into two or three small blades; of largest lateral tooth a flattened lobe which is barely indicated in the species of E studied. Maxilla with outer flattened blade conspicuous; palpus near its base on side, similar to the condition obtaining in Eriocera; just laterad of palpus a powerfu

Pupa.— Length, 9.2–9.6 mm.
Width, d.-s., 1.2 mm.
Depth, d.-v., 1.4 mm.

upa (Plate LI, 247) very similar to that of *Eriocera longicornis*, differing only in its small greater development of scapal spine, lack of projection on mesonotal prescutum, and v lesser characters. Cephalic crest (Plate LI, 248 and 249) as viewed from beneath, different in shape. Fore pair of legs much shorter than the others, ending just beyond erior margin of second abdominal segment; hind pair of legs extending far beyond the rs, ending beyond midlength of third abdominal segment; in some specimens the tarsal ients much closer to posterior margin of third abdominal segment, but usually a marked rence in tips of tarsi of the various legs. Cephalic crest as viewed from side, triangular, ng in an acute point directed strongly forward. Viewed from beneath, lobes conspicu- y triangular, pointed, lying parallel or slightly divergent and separated by a deep ian split. Spine on scape of antennae very large, conspicuous. Tubercle on labrum ngly developed. Antennal sheaths of male very long, those of female much shorter. otal breathing horns short, straight. Mesonotum strongly wrinkled along median scutellar lobe not developed. Wing pads dark, venation not showing clearly but, if e out, the very short cell R_2 and the reduced M characteristic of Hexatoma alone. erior leg sheaths extending beyond level of middle legs, these, in turn, being longer sheaths of fore legs.

odomen (Plate LII, 252) with about thirty-four spicules on sternite 4, about thirty straight, uninterrupted row on tergites 3 and 4, and about twenty on tergite 5. etotaxy about as in *Eriocera longicornis*, but the seta lying ventrad of spiracle on pleurites n farther ventrad and very weak. Male cauda with sternal lobes strongly rounded, rged, and bent suddenly dorsad. Female cauda as that of male; ovipositor viewed side with an obtuse notch; from beneath, sternite obtusely pointed and with a deep an split; from above, tergite almost flat across caudal margin, the lateral angles rounded, a deep median split.

epionotype.— Ithaca, New York, May 6, 1914.
eanotype.— Type locality, May 2, 1913.
aratypes.— Several hundred larvae and pupae from type locality.

ius **Eriocera** Macquart (Gr. *wool* + *horn*)

1830 *Caloptera* Guér. Voyage de la Coquille, Zool., Ins., pl. 20, fig. 2.
1838 *Eriocera* Macq. Dipt. Exot., vol. 1, p. 74.
1838 *Evanioptera* Guér. Voyage de la Coquille, Zool., vol. 2, part 2, p. 287.
1848 *Pterocosmus* Walk. List Dipt. Brit. Mus., vol. 1, p. 78.
1850 *Allarithmia* Loew. Bernstein und Bernsteinfauna, p. 38.
1857 *Oligomera* Dolesch. Natuurk. Tijdschr. Nederl. Indie, vol. 14, p. 387.
1859 *Arrhenica* O. S. Proc. Acad. Nat. Sci. Phila., p. 242.
1859 *Physecrania* Bigot. Ann. Soc. Ent. France, ser. 3, vol. 7, p. 123, pl. 3, fig. 1.
1912 *Androclosma* Enderlein. Zool. Jahrb., vol. 32, part 1, p. 34.
1916 *Globericera* Matsumura. Thous. Ins. Japan, add. 2, p. 471.

rva.— Spiracular disk surrounded by four lobes which are rarely (as in *Eriocera cinerea*, bsolete, inner face lined with brown or black, tips with fringes of moderately long hairs. l capsule long, narrow, the constituent plates very slender; dorsal plate completely ed tho contiguous or approximated behind. Labral sclerite large and conspicuous, ory tubercles and papillae crowded on median cephalic region. Mandible long, acute

at tip, with two teeth at about midlength. Maxilla with outer lobe greatly prolonged i a flattened blade. Antenna cylindrical or clavate, with three or four long papillae at Mentum not chitinized, in *E. cinerea* with a flattened rectangular plate on either side, armed with numerous hooks and spines.

Pupa.— Cephalic crest of various shapes and sizes, very reduced in *Eriocera spin* Antennal sheaths of males of several species (*E. spinosa, E. longicornis, E. cinerea*) v long, extending beyond end of wing pad. Pronotal breathing horns of various shapes, acu pointed in *E. spinosa*, short and blunt in several species. Head and thorax often w spines or tubercles on scape of antenna, on labrum, or (in *E. spinosa*) on face of eye tubercle on scutellum (in *E. longicornis*), one on dorsum of second abdominal segment (i *spinosa*). Abdominal segments with a conspicuous transverse armature of spines posterior margin. Lateral spiracles large, distinct.

Eriocera is an extensive genus (including approximately 150 speci of medium-sized to large flies, most of which are tropical. The ge has not been found in Europe, but elsewhere it is represented by a h of species. The habits of the adult flies have already been noted (pa 704). The immature stages are spent in sand or gravel near runni water, more especially along large streams. A more complete acco of the genus is given by Alexander and Lloyd (1914) and by Alexan (1915 c: 148–152).

The occurrence of the flies is somewhat local. During an entire summ of collecting in Maine in 1913, the writer did not find a single specim of any species; and Dr. Dietz has stated that the only living individu which he has found was a single male of *Eriocera spinosa* taken in t Pocono Mountains in Pennsylvania. On the other hand, the flies often found in countless numbers, and several species may be fou associated together. Thus, at Ithaca, New York, in the sandy gra along Cascadilla Creek, the immature stages of four species of Erioc and one of the closely related Hexatoma occur together in unlimit numbers.

The species of Eriocera may be separated by the following keys:

Larvae

1. Lobes surrounding spiracular disk obsolete or nearly so; a flat, chitinized plate with s rate margins on either side of mental region ..... *E. cinerea* Alex. (p. 8
   Spiracular disk surrounded by four slender lobes; no plate as described above on men region .....
2. Very large (length 40–45 mm., diameter 4–5 mm.); spiracular disk with ventral lo narrowly lined with black, inner ends of each forked, Y-shaped; lateral lobes narro lined with black, inner ends of marks expanded ..... *E. spinosa* (O. S.) (p. 8
   Smaller (length under 30 mm., diameter under 2.5 mm.); spiracular disk not mar as above .....

ral lobes of spiracular disk bearing one or two very long, dark setae in addition to e shorter yellowish fringe; inner face of each lobe with a capillary black line which suddenly expanded at its inner end into a triangular brown mark, the two marks closing an oval pale area between their proximal ends; lateral lobes with a capillary ack line..... *E. fultonensis* Alex. (p. 890)
ral lobes of spiracular disk with apical fringe consisting of numerous long, pale setae; ner face of each lobe lined with pale brown, at about midlength gradually expanded to an elongate-triangular mark, the two marks inclosing a linear pale area between eir proximal ends; lateral lobes with a brown line..... *E. longicornis* (Walk.) (p. 888)

Pupae

large (length 25 mm. or over); pronotal breathing horns tapering to acute tips; phalic crest small, reduced to four small tubercles; cell M_1 on wing pad present; strong spinous tubercle on either side of median line at base of second abdominal rgite; a tubercle on eye..... *E. spinosa* (O. S.) (p. 883)
smaller (length under 18 mm.); pronotal breathing horns blunt at tips; cephalic est prominent; cell M_1 on wing pad lacking; no tubercles on second abdominal tergite on eye..... 2
bercle on mesonotal scutellum..... *E. longicornis* (Walk.) (p. 888)
ubercle on mesonotal scutellum..... 3
rites of abdominal segments with a transverse row of three setae ventrad and slightly udad of spiracle; antennae of male elongated..... *E. cinerea* Alex. (p. 886)
rites of abdominal segments with two stout setae dorsad and caudad of spiracle; tennae short in both sexes..... *E. fultonensis* Alex. (p. 890)

ra spinosa (O. S.)

9 *Arrhenica spinosa* O. S. Proc. Acad. Nat. Sci. Phila., p. 244.
9 *Eriocera spinosa* O. S. Mon. Dipt. N. Amer., part 4, p. 252–253.

ocera spinosa is the commonest of the large species of the genus tern North America. The larvae occur in great numbers beneath in rapid water in the autumn, when they form a considerable pro- n of the insect life in the streams. When about to pupate they go neighboring banks and live for some time in the sand or gravel. abits of the larvae have been discussed by Alexander and Lloyd 16–17) and by Alexander (1915c:149).

larvae were found on May 1, 1913, along the banks of Fall Creek, , New York, in considerable numbers. They were associated with and mature pupae of *E. longicornis*, which were emerging in great rs at the time. On May 27, both larvae and pupae of *E. spinosa* ound to be very abundant, the larvae being more numerous in the places, the pupae in the drier spots. They occurred at various es from the water's edge, from within a foot of the margin to as k as eight or ten feet. The pupae are found in short, more or less l, burrows, from one to three inches below the surface. Not often

were larvae and pupae found in close proximity to each other. P
of *E. spinosa*, as well as of all other species of the tribe as known,
very active when removed from their burrows, wriggling rapidly to
fro, and are exceedingly tenacious of life. Larvae, as found on
27, were mostly contracted; a few, however, were expanded and ha
subterminal segment of the abdomen swollen. In this regard it ma
mentioned that almost all of the larvae of crane-flies that live in the
or mud along the banks of streams have this ability to inflate the
of the abdomen. Larvae of Eriopterini, of Pediciini, and of Hexato
have been observed with this conspicuous enlargement. It is undoub
used to propel the larva thru the soil by alternate expansion and
traction of the segment.

Larvae of *E. spinosa* were placed in breeding jars on May 13 and
flies emerged on the 28th. It is probable that the pupal stage is
longer than from ten to twelve days, at the most. On May 30 a
number of larvae and pupae were brought into the laboratory in a bu
of gravel. Some of the fully matured pupae transformed in the
while being brought to the laboratory.

The larvae are carnivorous. Their powerful, sickle-shaped mand
are capable of inflicting a painful bite on tender parts of the hand.
Rich placed larvae in dishes together with the nymphs of various d
flies. The smaller of the nymphs were eaten by the Eriocera larvae,
confirming previous observations on the carnivorous habits of the sp

Larva.— Length when fully extended, 40–45 mm.
Diameter, 4–5 mm.

Color varying from very pale whitish to rather dark brown; in life, the skin sh
conspicuous bronzy reflections.

Spiracular disk (Plate LIV, 262) surrounded by four slender elongate lobes, one pair
lateral, the other ventral, in position; inner face of lateral lobes with a capillary blac
this beginning as an enlarged black spot just ventrad of spiracle, reaching tip of lobe;
outer edge of lobe with a dense fringe of long, conspicuous, reddish hairs, inner edge
beginning just laterad of spiracle where the hairs are very short, gradually becoming
to tip, where they are as long as the lobe itself; ventral lobe with a capillary black
proximal edge, this dividing at base of lobe, the lower branch running along ventral
of stigmal field and approaching its fellow of the opposite side on median line of b
dense fringe of conspicuous reddish hairs at tip of lobe and continued on outer dors
for a short distance toward base; a few dusky brown spots on stigmal field between spi
two small hairs between spiracles. Spiracles rather small, widely separated. Unde
caudal lobes and behind penultimate swollen segment, four anal gills, short, stout, cylin

teral pair directed outward, the inner pair directed caudad. Head capsule (Plate 267) broad in proportion to its length, measuring 3.5–3.8 mm. by 1.8–2 mm. (across plates). Papillae at tip of antenna short, not more than one-third length of seg- Mandible (Plate LIV, 271) lacking a prominent conical tooth at midlength, such as id in *E. cinerea* and other species.

a.— Length: male, 26.5–27 mm.; female, 25–28.5 mm.
Width, d.-s.: male, 3.4–3.9 mm.; female, 3.4–4 mm.
Depth, d.-v.: male, 4–4.2 mm.; female, 3.5–4 mm.

ife, pupae varying in color from very pale yellowish to dark brown or almost black, epest color being that of head and thorax of old pupae; body often showing bronzy ions.

halic crest very reduced, scarcely projecting beyond level of antennae; viewed from h, somewhat quadrate, the anterior lateral angles produced into small pointed lobes g a small seta at apex; viewed from side a second pair of lobes is seen, these being ual to anterior lobes in size, and likewise setiferous. Spine of antennal scape very somewhat curved, directed ventrad. Inner caudal surface of eye with a conspicuous le. Tentorial region produced into a small median tubercle. Tubercles at base of very large, close together, their tips strongly chitinized; a small seta above each e labral tubercles and another small seta on each cheek. Pronotal breathing horns lender, broad at base, flattened and rather pointed at tips, the organ arcuated so that bent strongly ventrad. Mesonotal scutellar lobe (Plate LV, 280) prominent, rather y projecting. Wing pad light brown, venation showing very clearly, the presence of in connection with elongate antennae in male sex being found in this species alone ern North America. Leg sheaths with tarsal sheaths ending on a level, about opposite third abdominal segment.

nd abdominal tergite with a conspicuous basal tubercle on either side of median line. inal segments (Plate LVI, 283) with subterminal rows of spines, there being about to twenty-two on tergites 2 to 5; tergites 6 and 7 destitute of spines but with four cal setiferous tubercles; tergites 2 to 7 with a conspicuous setiferous tubercle on ventro- c angle of each posterior ring; eighth tergite concave on posterior margin, bearing a strong apical tubercles on either side of median line. Pleural region of abdomen restricted, longitudinally wrinkled. Spiracles large, elliptical, transverse, placed about e midlength of segments. Three small setiferous tubercles ventrad and caudad of , and another similar tubercle on dorso-cephalic angle of each pleuron. Sternites nent 3 with two spines on each outer angle; segments 4 to 6 with from sixteen to twenty segment 7 with about ten spines; an isolated setiferous tubercle caudad and dorsad of row; segments 4 to 7 with a setiferous tubercle about midlength of posterior ring; t 8 lacking soft pleural region, bearing an apical row of strong spines which are inter- only on dorsum and for a small space on median line of venter, there being about of these spines in the circlet. Male cauda (Plate LV, 281 and 282) with ninth sternite d, swollen, with a deep median furrow bearing a small lobe on ventral side at end of inth tergite produced caudad into two strong conical points separated by a V-shaped these points directed caudad and slightly dorsad, each one a little split near tip on ace and with a prominent lateral tooth at about midlength. Female cauda (Plate

LVI, 284) with ninth sternite elongated, cylindrical, its tip rounded, feebly split ber ninth tergite very long, pointed, with a deep median split.

Nepionotype.— Ithaca, New York, May 1, 1913.
Neanotype.— With type larva.
Paratypes.— Numerous larvae and pupae with types, May 1–15, 1913.

Eriocera cinerea Alex.

1912 *Eriocera cinerea* Alex. Psyche, vol. 19, p. 169–170, pl. 13, fig. 9.

Eriocera cinerea is locally common, flying in May. The larvae found on May 16, 1917, in sand along the banks of Cascadilla C Ithaca, New York. They have been found at various dates during past few years, but always in scanty numbers. Larvae found on 28 were associated with larvae of *Hexatoma megacera*, *Eriocera spi* Atherix, and other insects. The larvae are stouter than those o *longicornis* and are pale whitish yellow, quite devoid of the greenish of the latter species. A larva found on April 28 transformed to an female on May 16. Additional larvae and pupae were found on 24, and a few pupae on May 30, 1917.

The supposed larva of *E. longicornis* described by Alexander and L (1914:21–23) pertains to this species; the true *longicornis* is discu later in this paper.

Larva.— Length, 15–16 mm.
Diameter, 2–2.2 mm.

Color light yellow.

Form almost terete, abdominal segments subdivided into two annuli. Subter abdominal segment greatly enlarged, capable of great distention. Spiracular disk (LIV, 263 and 264) very reduced, the usual four lobes exceedingly small; ventral lobes tically obsolete, not projecting, each fringed with from twenty to thirty long, golden-y hairs; lateral lobes very short, triangular, fringed with from twelve to fifteen long a faint dusky mark from dorsal margin of each spiracle to edge of field; a faint vertical between spiracles; ventral lobes marked with brownish black, the mark of each side pointed at its inner end, the innermost of these points connected with its fellow o opposite side; lateral lobes with the marks elongate, triangular, the points directed out Spiracles small, oval, separated by a distance a little less than the diameter of one. gills four, very short and inconspicuous.

Head capsule long and narrow, measuring about 1.5 by 0.275 mm.; dorsal plates of ca with proximal anterior angles produced inward. Labral sclerite (Plate LII, 253) h labrum itself subquadrate. Mental region entirely lacking strongly chitinized points this group of genera. Present species showing a structure which is probably a part of la either mentum or hypopharynx, and which has not been found in any other species

s (Plate LII, 254); this structure located on either side of capsule on ventral face, a ned, subrectangular plate whose surface, except at base, is densely set with small spines large pits; inner margin provided with large, acute spines, beginning at about one- length of sclerite, gradually enlarged toward tip, at inner angle acute; these teeth inter- d before outer posterior angle, which terminates in a blunt, flattened lobe. Antenna drical, apex obliquely truncated, terminating in a slender apical papilla which is longer the segment that bears it, broad at base, tapering gradually to tip; two or three long l setae; small auditory plates at about one-third length of segment. Mandible (Plate 255) a powerful, slender, curved hook, at about midlength with a strong pointed tooth ng in its axil a smaller tooth; as is usual in the genus, an egg-shaped chitinized piece ed in one of the ventral tendons of mandible. Maxilla arising just ventrad of man outer lobe persisting as a very elongate, bladelike organ.

pa.— Length, 13–15 mm.
Width, d.-s., 1.6 mm.
Depth, d.-v., 1.7 mm.

ad and appendages dark brown, thoracic dorsum a little paler; abdomen with posterior of tergum and sternum dark brown, producing a banded appearance.

phalic crest (Plate LIII, 257) very large and conspicuous, consisting of two rounded behind, each tipped with a strong seta; anterior part of crest directed ventrad and con- g of two lobes, the larger bearing a strong seta on outer face; viewed from front, these or lobes separated by a very narrow, U-shaped, median notch; crest of female a little er. Two blunt tubercles on scapal segments of each antenna. Junction of clypeus and n with two tubercles, above and slightly laterad of each a strong seta. A strong seta eek below eye. Labrum broad, very obtusely rounded at tip. Labial lobes rectangu- idely separated. Maxillary palpi blunt at tips (Plate LIII, 258). Antenna of male elon- exceeding wing and ending opposite base of last tarsal segment of hind leg. Pronotal ning horns short, slender, cylindrical, scarcely longer than cephalic crest. Two long l setae and a smaller straight seta laterad and ventrad of base of each breathing horn. al angle of thorax with two setae; two long setae above wing axil (Plate LIII, 256). ong seta on either side of mesonotum and a group of two small setae in front of each se. Wing sheaths extending to base of third abdominal segment. Leg sheaths extend- base of fourth abdominal segment; tarsal sheaths ending about on a level, or those e legs considerably shorter.

dominal segments (Plate LIII, 259) divided into two subequal rings. Chaetotaxy as s: pleura with a seta on dorsal margin of basal ring; a transverse row of three setae terior ring, lying ventrad and slightly caudad of spiracle (as in *E. spinosa*); tergum with ring unarmed, posterior ring with a subterminal row of sharp black spines; two long at each end of row and a few small setae at intervals along row; a solitary seta on basal part of posterior ring; armature weaker on posterior segments, on segment 7 being ed to four separated groups of setae, the outer groups with a single spine; sternum with ring unarmed, posterior ring with a subterminal transverse row of stout black spines wo long setae at each end of row and an isolated seta laterad and caudad of end of t base of ring on either side a group of two setae, the lateral one the smaller. Male (Plate LIII, 260) with the sharp dorsal lobes directed dorsad, rather acute at tips, two

setae on outer face before tips; viewed from above, these setae seen to be separated deep U-shaped notch; eighth segment with a dorsal pentagon of five closely approxim lobes; just laterad of these a group of three setae, the posterior one long and slender. anterior one short and stout; pleural region produced into a long lobe tipped with a sle seta; on sternum two small setae on either side. Female cauda (Plate LIII, 261) elon tergal valves very long and slender, two delicate setae on either side before tip and a st one at tip.

Nepionotype.— Ithaca, New York, April 28, 1917.
Neanotype.— Fall Creek, Ithaca, May 18, 1917
Paratypes.— Larvae and pupae with types.

Eriocera longicornis (Walk.)

1848 *Anisomera longicornis* Walk. List Dipt. Brit. Mus., vol. 1, p. 82.
1869 *Eriocera longicornis* O. S. Mon. Dipt. N. Amer., part 4, p. 253–254.

Eriocera longicornis is probably the commonest species of the ge in the eastern United States. The adult flies are sometimes very abunda occurring in swarms in late afternoon and early evening in May, s of the swarms numbering thousands of individuals. At other times the day, the flies may be found resting quietly on bushes. The lar live in the sand near the water's edge. The pupal duration is seven d The detailed life history of this species is given on pages 704 to 708.

Larva.— Length, 17–19 mm.
Diameter, 2–2.3 mm.

Color, greenish brown.

Body covered with a long, appressed, dark pubescence. Penultimate segment of abdo capable of great distention and destitute of pubescence; last segment of body conspicu narrowed. Spiracular disk (Plate LIV, 265) surrounded by four slender lobes, the ve pair the longer, bearing at tip elongate hairs, some of which exceed the lobes in length lateral face at about midlength a small pencil of hairs; on ventral face one or two long s inner face of ventral lobes lined with pale brown, beginning as a narrow brown mark at at about midlength gradually expanded into an elongate triangular mark, the two inclosing between their inner ends a pale linear mark; lateral lobes similar to ventral l fringed with long yellow hairs which are longer than the lobes; inner face of lateral lobes with pale brown. Spiracles rather large, separated by a distance equal to about one and half diameter of one. Anal gills pale. A few setae in transverse alinement on last seg behind lateral lobes. Two pairs of short black setae behind gills.

Head capsule and mouth parts very similar to those of Hexatoma, dorsal plates of ca separate from each other, not fused as in the Ulomorphae; inner margins of dorsal p straight and parallel. Labral sclerite broadly transverse, narrowed at ends, lateral ma produced into long lobes which are densely tufted with short, golden-yellow hairs. M lobe of epipharyngeal region projecting, provided with two large sensory papillae, o either side, and a few other setiferous papillae near tip, surrounded by numerous

nna elongate, a little narrower at base, at tip with three or four hyaline, seta-like papillae
n are of various diameters and shorter than the segment, the largest of these papillae
tely sculptured with transverse lines. Mandible acute, curved, at about midlength
a blunt, flattened tooth, this with a smaller similar tooth in its axil. Maxillary blade
long and slender, about half length of capsule.

.— Length: male, 13.2–15.2 mm.; female, 14–15.4 mm.
Width, d.-s.: male, 2.1–2.2 mm.; female, 1.8–1.9 mm.
Depth, d.-v.: male, 2.1–2.3 mm.; female, 2.2 mm.

ung pupae very pale; soft abdomen almost white; chitinized anterior part of body very
brown. Older pupae much darker, the chitinized part becoming black with a bronzy
tion; abdomen very dark brownish gray; breathing horns dark brown on apical half.
phalic crest (Plate LV, 275) very prominent, elongate, tapering to the subacute tips;
with blunt tubercles behind, as well as four long setae on each lobe, three on dorsal
in and a longer one on lateral face at about midlength; viewed from in front, lobes
rated by a broad, square or U-shaped notch; ventral part of crest produced forward
een antennal bases as a depressed lobe bearing a stout seta on either side. Tubercle
ntennal scape very prominent. A slightly smaller tubercle on either side of clypeus,
a small rounded knob cephalad of each. Labrum truncated. Labial lobes roughly
ond-shaped. Maxillary palpi very broad, rectangular, tips truncated. Antennal
hs of male greatly elongated, enlarged at base; viewed from beneath, the swollen bases
y contiguous on median line, just above and proximad of inner margin of eye, with
l tubercle described above. Antenna of male exceeding wing pads, those of female
g just beyond wing base. Pronotal breathing horns short and stout, straight, trans-
ly wrinkled, directed cephalad, dorsad, and laterad; when viewed from beneath, com-
y concealed by large cephalic crest. Thoracic notum convex; mesonotum transversely
kled (Plate LV, 277); median lobe of mesonotal scutellum projecting dorsad and cau-
as a blunt point (Plate LV, 272). Two or three setae above wing axil. Lateral angles
orax subacute, with a weak seta. Wing sheaths attaining end of second abdominal
ent. Leg sheaths ending before caudal margin of third abdominal segment; tarsi of
legs the longest, the two inner pairs ending about on a level (Plate LV, 273).
dominal segments (Plate LVI, 285) divided into a basal and a posterior ring; tergites
sterior ring with a subterminal transverse row of spines, these varying from about thirty-
n segment 3 to about fourteen on segment 7; these rows of spines interrupted on dorso-
an line; at each end of row, three long setae, and two additional groups of setae inter-
ed along row; two setae on either side at anterior-lateral angle of ring; tergites on basal
unarmed; sternites on posterior ring with a subterminal transverse row of from twenty-
to thirty-two spines, with two setae at each end of row; an isolated seta on caudo-
l margin, close to pleura; a group of two approximated setae near base of posterior
on either side, about at level of spiracles. Sternites on basal ring unarmed; pleurites
sal ring with a solitary seta at about midlength, but slightly nearer dorsal margin;
ior ring with two setae dorso-caudad of spiracle, and a third seta ventrad of it. Male
(Plate LVI, 286) very blunt, much narrower than remainder of abdomen; ventral
very blunt; dorsal lobes short, stout, ending in sharp points directed dorsad, on outer
long and a short seta; segment 8 with a dorsal trapezoid of four lobes, the posterior

pair the longer, each with two setae; anterior pair of lobes a little more widely separa laterad of latter pair of lobes, a tubercle bearing three setae; a long, powerful seta on ple two setae on either side of median line of sternum. Female cauda (Plate LV, 274) sim but ventral lobes more pointed, slightly exceeding level of dorsal lobes.

Nepionotype.— Ithaca, New York, April 18, 1917.
Neanotype.— Fall Creek, Ithaca, May 2, 1913.
Paratypes.— Several hundred larvae and pupae with types.

Eriocera fultonensis Alex.

1912 *Eriocera fultonensis* Alex. Psyche, vol. 19, p. 168–169, pl. 13, fig. 7.

Eriocera fultonensis is a rather common but usually local species thru the northeastern United States. The larvae are found in the same sit tions as are described for the other species of the genus, in sand or gra near the margins of usually large streams. On May 30, 1913, larvae w found in considerable numbers along the banks of Fall Creek, Itha New York, where they occurred in company with numerous larvae a pupae of *E. spinosa*, a few large tabanid larvae, a small tabanid pu and the following beetle associates: Bembidion, Schizogenius, Tach Gastrolobium, and a few others. The pupal duration is seven days (fr May 31 to June 6, 1913).

Larva.— Length, 18–26 mm.
Diameter, 2–2.3 mm.

Color, pale flesh yellow; anterior segments of body a little darker.

Body long and slender. Spiracular disk (Plate LIV, 266) with ventral lobes long and slen lateral lobes shorter; ventral lobes at their tips with one or two very elongate blackish h which are from two to three times length of lobes; in addition to these the usual apical fr of yellowish hairs not exceeding lobes; near base on outer side a small pencil of hairs; e ventral lobe with a very delicate capillary black line which expands abruptly at its in end into a brown area, these two areas inclosing between their proximal ends a more or oval pale area (in some specimens the inner ends completely encircling this pale area, w in others the brown lines are not continuous over the disk); lateral lobes shorter, simil fringed with yellow hairs which are longer than lobes; inner face of lobes with a capill black line. Spiracles rounded oval, widely separated.

Head capsule and mouth parts almost as in *Hexatoma megacera* and *Eriocera longicor* as already described; epipharyngeal region (Plate LIV, 268) produced into a hemisphe rounded lobe which is densely covered with fine hairs; two large papillae on either side tip, between them a terminal tuft of long yellow hairs surrounding two long, slender, s erous papillae. Antenna with sensory papillae at tip short, about one-third length of segm

Pupa.— Length, 14–16 mm.
Width, d.-s., 1.8–2 mm.
Depth, d.-v., 2.5–2.7 mm.

ly colored pupae dark brown; cephalic crest paler; pronotal breathing horns pale yellow, ning into brown at tips; wing pads light yellow, with dark venation showing clearly; tes of abdomen of a darker brown than sternites or tergites.

ly somewhat similar to that of *E. longicornis*, but general form much stouter. Cephalic (Plate LVI, 287) prominent, tuberculate, consisting of four lobes, the posterior lobes hat the larger, on posterior and lateral faces with two stout setae; a stout seta on l face of anterior lobes. Scapal spine lacking. Clypeal tubercles large, blunt, with ll setiferous tubercle above each. Labrum bluntly rounded at apex. Labial lobes ate, diamond-shaped, tips rather acute. Pronotal breathing horns rather long and r, transversely wrinkled, longer than cephalic crest. Mesonotum (Plate LV, 279) convex than in *E. longicornis*. Wing pads usually showing venation clearly on pale round; vein *r* connecting R_1 with R_{2+3} distinctive of this species, lack of cell M_1 ting this pupa from that of *E. spinosa* and *E. brachycera*. Legs sheaths ending about evel, the hind tarsi a little longer than the two inner pairs.

angement of setae on abdomen (Plate LVI, 288) about as in *E. longicornis*. Pleura wo stout setae dorsad and caudad of each spiracle, and a weak seta ventrad of spiracle ose to it; basal ring with a single pleural seta; spicules on caudal margin of posterior mall and numerous, on intermediate segments about forty in number; seventh sternite bout four to six spines at each end of row, the broad median area devoid of spines. e cauda (Plate LV, 276) with tergal valves exceeding the long sternal valves, y directed dorsad (this condition may be compared with that in *E. longicornis*). Male with abdomen bluntly rounded at tip.

ionotype.— Ithaca, New York, May 30, 1913.
notype.— With type larva, June 6, 1913.
atypes.— Larvae and pupae with types.

s **Penthoptera** Schiner (Gr. *sorrow + wing*)

63 *Penthoptera* Schin. Wien. Ent. Monatschr., vol. 7, p. 220.

a.— Spiracular disk surrounded by four blunt lobes, the ventral pair a little the longer, face not marked with darker, at tip with one or more long setae. Head capsule about Eriocera. Coloration a deep saturated yellow.

a.— Cephalic crest with lobes rounded, setiferous. No distinct tubercles or spines d or thorax. Pronotal breathing horns short, stout, cylindrical, apex expanded into ened head, stem coarsely wrinkled, base enlarged. Abdominal armature weak. les not well developed.

nthoptera is a small genus which includes four European and three ican species, two of the latter occurring in tropical America. The rn North American *Penthoptera albitarsis*, discussed below, has been dered in some detail by the author in another paper (Alexander, c: 152–157).

Penthoptera albitarsis O. S.

1869 *Penthoptera albitarsis* O. S. Mon. Dipt. N. Amer., part 4, p. 257–258.

The larvae of *Penthoptera albitarsis* are usually not uncommon in ri organic mud in shaded places thruout the range of the species. Larv of many sizes, some very small, others apparently almost fully grow may be found at a single time. This would probably indicate that t species emerges at intervals thruout the summer, rather than that it double-brooded.

Larva.— Length, 10–12 mm.
Diameter, 1–1.2 mm.

Color bright chestnut-yellow, anterior half of body richer- and deeper-colored; thora segments suffused with brown; skin with a silky, iridescent reflection.

Body provided with numerous long, appressed hairs. A few setae on body, the follow being the most conspicuous: one on lateral dorsal margin of last segment, near base lateral lobes; a series of four groups of one or two in each row across dorsal surface of three thoracic segments at about midlength; a group of two or three long setae on sides a caudal margin of segments. Subterminal enlargement of abdomen with about twenty-f transverse rows of fine points.

Spiracular disk (Plate LVII, 292 and 293) with four blunt lobes; ventral lobes den fringed with long, pale hairs, those toward ends of lobes longer; one or more elongate se near tip of each ventral lobe, these being longer than lobes themselves; lateral lobes w a similar fringe of rather short, yellow hairs; spiracular disk almost free from dark ma ings, a pale brown line extending dorsad from each spiracle and an indistinct brownish l along ventral margin of lateral lobes. Spiracles circular. Anal gills four, pale. He capsule rather broad, dorsal plate with inner anterior angles rounded. Labrum (Pl LVII, 289) almost as in *Eriocera spinosa*, the extreme cephalic epipharyngeal parts with usual papillae and setiferous tubercles; lateral papillae bearing at their tips three or f slender pegs; between these papillae two pairs of setiferous tubercles, a basal larger p and a more apical smaller pair. Mandible (Plate LVII, 291) a little more curved than usual in this subtribe, inner margin with a double tooth at about midlength.

Pupa.— Length, 10–10.5 mm.
Width, d.-s., 1.4–1.5 mm.
Depth, d.-v., 1.5–1.6 mm.

Thorax dark brown, wing and leg sheaths paler; pronotal breathing horns dark brow swollen bases and tips much paler, light orange; abdomen brownish yellow.

Cephalic crest consisting of two widely separated rounded lobes behind, each bearing t setae; anteriorly the crest appearing as a large depressed lobe between antennal bases, w a very large, stiff seta on either side. A powerful seta on each side of region of clypeus. seta on genal region between eye and sheath of maxillary palpus. Labrum evenly round or a little truncated at apex. Labial lobes widely separated, roughly rounded or indistinc pentagonal in outline. Maxillary palpi broad, ending bluntly beneath or just before anten sheaths. Antennae ending just beyond wing root in female, considerably longer in m

otal breathing horns (Plate LVII, 294) short, stout, cylindrical, apex expanded into a ned circular head, stem coarsely and transversely wrinkled, base enlarged; breathing widely separated at their bases, but bent proximad so as to be almost contiguous at their two strong setae laterad of base of breathing horn and an additional one in front of it. notum transversely wrinkled, with a distinct carina anteriorly (Plate LVIII, 296). Two os of two setae on either side of median line, with an additional solitary seta; two longer above wing axil. Wing sheaths ending before tip of second abdominal segment. Leg is ending at from two-thirds length to opposite end of third abdominal segment; tarsal is ending about on a level, or, in some specimens, the hind tarsi a little longer than the s (Plate LVIII, 297).

domen indistinctly divided into a narrow basal ring and a broader posterior ring; basal further very indistinctly subdivided into two subequal annuli. Abdominal armature ; on sternites a subterminal transverse row of delicate spines with two setiferous tubercles ch end of row; on posterior ring two setae on either side at about midlength; tergites four groups of two or three setae near posterior margin and an additional group of two on lateral margin of posterior ring near base; pleural region with a stiff seta on extreme ior part of basal ring. Spiracles distinct; a group of two setae caudad and slightly ad of each spiracle, with an additional solitary seta caudo-ventrad of these. Female (Plate LVIII, 298) with tergal valves of ovipositor only a little longer than sternal s, at tip ending in a short, rather blunt point directed dorsad; on outer face before tip rt, stiff seta; segment 8 on dorsum with a close trapezoid of four irregular lobes; two rous tubercles on dorsal and lateral part of eighth segment, the more dorsal of these two setae, the lateral one with a single seta; sternum with four stout setae, of which two ateral and two are median in position. Male cauda (Plate LVII, 295, and Plate I, 299) with sternal valves short and blunt; tergal valves slender, ending in an acute directed dorsad; a few short setae on outer face before tip.

pionotype.— Ithaca, New York, May 25, 1917.
anotype.— Bool's hillside, Ithaca, June 5, 1917.
ratypes.— Abundant larvae and a few pupae with types.

Subtribe **Polymeraria**

us **Polymera** Wiedemann (Gr. *many* + *part*)

821 *Polymera* Wied. Dipt. Exot., vol. 1, p. 40.

olymera is a tropical American genus including fifteen described ies, one of which, *Polymera georgiae* Alex., occurs in the southeastern ed States. A single additional species, *P. magnifica* Meunier (1906: , has been described from the Baltic amber (Lower Oligocene). The species concerning the ecology of which we have any record is *P. ulata* Alex., which has been found living in crabholes beneath rocks orto Rico. In this connection the long-horned deinoceritine mosquitoes

which live in similar habitats should be considered. Howard, Dyar, a Knab (1915:213) say, in describing these mosquitoes:

> These crab-hole inhabiting species possess peculiarly developed antennae in order, as suppose, to enable them to detect the approach of their crustacean host and fly out of t holes before being overwhelmed in the water in the bottom by the incursion of the cr whose body must completely fill the entrance to the hole.

It is curious and suggestive that the males of Polymera should likew possess elongated and very complicated antennae.

Tribe Pediciini

The Pediciini constitutes a small tribe which seems to be divisible in two well-marked subtribes, the more generalized Adelphomyaria indicati a relationship with the Hexatomini.

The larvae of the Pediciini have the labrum broad and the epipharyn usually feebly armed. The mentum is completely divided into two part each half with not more than four, usually three, teeth. The hypopharyn is labriform. The maxilla consists of two lobes, distinct and separa in the Adelphomyaria, more or less approximated or fused in the Ped caria. The mandible is powerful, ending in a strong apical point; th cutting edge has about four teeth; there is a simple tuft of setae on th prosthecal region in the Dicranotae and in Pedicia. The head capsu is very elongate, massive, and compact, with the posterior incisions ve shallow. In the Adelphomyaria the cauda is surrounded by four lob which are fringed with exceedingly elongate hairs; in the Pedicaria the are two ventral caudal lobes, each tipped with a very few setae. Th anal gills are four in number and are segmented, the terminal segme being more or less retractile. In the Pedicaria prolegs are develope on the abdominal segments of some of the genera.

All of the species of the tribe, so far as is known to the writer, a carnivorous in their larval state, which is spent in mud or earth close water.

The two subtribes of the Pediciini may be separated as follows:

Larvae

Spiracular lobes four in number, fringed with very long, delicate hairs.
Adelphomyaria (p. 89

Spiracular lobes two in number, ventral in position, each tipped with from six to eight set
Pedicaria (p. 89

e most important literature on the tribe Pediciini is as follows:

a rivosa	General	Scheffer, in Rossi, 1848:9.
a rivosa	Larva, pupa, general	Beling, 1879:45–46.
a rivosa	General	Reuter, 1893.
a rivosa	General	Wesenberg-Lund, 1915:335.
a albivitta	Larva	Needham, 1903:285–286; 1905:8.
hona immaculata	Larva, general	Beling, 1879:47.
hona immaculata	Larva, pupa, general	De Meijere, 1916:195–196.
hona schineri	Larva, pupa, general	Beling, 1879:47.
ota bimaculata	Larva, pupa, general	Miall, 1893.
ota bimaculata	Larva, pupa	Grünberg, 1910:66–67. (Copy.)
ota bimaculata	General	Wesenberg-Lund, 1915:342–343.
ota bimaculata	Larva	Malloch, 1915–17 b:219–220. (Copy.)
idolabis tenuipes	Larva, general	Needham, 1908 a:212–214.

Subtribe **Adelphomyaria**

e division Adelphomyaria, as known, includes but the single genus homyia Bergroth, a curious genus of small crane-flies which, in the al appearance of the adults, strongly suggest the hexatomine sub- Limnophilaria. The immature stages have not been associated with dult flies by rearing, and there is, of course, the possibility of a ken reference. The immature stages of the insect herein described asily recognized, however, and, no matter to what group it belongs, erves subtribal rank under the Pediciini.

s **Adelphomyia** Bergroth (Gr. *brother* + *fly*)

91 *Adelphomyia* Bergr. Mittheil. Naturf. Ges. Bern, 1890, p. 134.

a (supposition).— Body with pencils of stiff setae, producing a spiny appearance. lar disk surrounded by four short lobes which are fringed with exceedingly elongate Spiracles large, separated by a distance less than the diameter of one. Head cap- g and massive, all the plates firmly united except behind. Mandible acutely pointed. of two elongate separated lobes. Antenna two-segmented, the terminal segment ree small papillae. Hypopharynx labriform. Mentum completely divided, each th four teeth, the middle pair on each side the largest (*minuta*, supposition) or the from the inside the largest (*americana*, supposition).

a (supposition).— Cephalic crest small, each lobe with three setiferous tubercles. l breathing horns moderate in length, broadly tipped with light yellow. Mesonotum d. Wing sheaths extending beyond base of third abdominal segment. Leg sheaths ng to beyond base of fifth abdominal segment. Abdominal armature weak, especially erior segments.

lphomyia is a small genus of crane-flies, including but four European ree North American species, and a doubtful species from Africa. The

insects resemble tiny species of the genus Limnophila. The adult fli are not uncommon on rank herbage, especially ferns, in woods and usual near running water. As already stated, the immature stages have n been reared, but larvae found by the writer in Maine are referred wi considerable confidence to *Adelphomyia americana* and *A. cayuga*, wh larvae and pupae of another species taken at Ithaca, New York, seem be those of *A. minuta*. The larvae show a curious combination of tri characters. The general appearance and the structure of the spiracul disk are altogether those of one of the Hexatomini; but the head caps and the details of the mouth parts indicate a relationship with the Pe ciini that cannot be denied.

Adelphomyia minuta Alex. (supposition)

1911 *Adelphomyia minuta* Alex. Can. Ent., vol. 43, p. 287–288.

Adelphomyia minuta is a characteristic late spring species, common boggy woods and on vegetation along rapid streams. Larvae and pup which are referred to this species were sifted from organic mud taken Bool's hillside, Ithaca, New York, thruout May and early June, 19 The pupae referred to this species strongly resemble those of Dicran phragma but in reality are very different. The species is discus herewith in the hope that it may be definitely recognized in the future.

Larva.— Length, 4.5–5 mm.; caudal fringe, 2 mm. additional. Diameter, 0.4 mm.

Coloration, saturated yellow with a faint orange-brown tinge.

Form narrow, body tapering gradually to both ends, spiracular disk narrowed. Bo clothed with a delicate appressed pubescence and numerous tufts of conspicuous stiff ha which produce a spiny or bristly appearance; the more conspicuous of these tufts located pleural region, there being three such rows on abdominal segments — one on basal ring, second and largest at base of posterior ring, and the third just before posterior margin segment and more ventral in position; only the large intermediate tuft present on thora segments, the small brush on anterior annulus of abdominal segments lacking. Spiracu disk (Plate LIX, 305) with four lobes; ventral pair not more than three times length of late pair; inner face of lobes margined with brown; at tip of ventral lobes a fringe of exceedin elongate hairs, which are from one-third to nearly one-half length of entire body and ab fifteen times length of lobes bearing them; a stiff sensory bristle located in black mar at tip of lobe; lateral lobes with fringe of hairs relatively much shorter, tho still lo Spiracles large, close together, separated by a distance less than diameter of one, the mid piece black, the ring pale yellow. Anal gills four, slender, hyaline, each subdivided by c strictions into four lobes which are gradually narrowed from the base outward, the last be cylindrical.

ad capsule very compact, lateral plates united with broad dorsal plate except for a short nce behind. Labrum (Plate LIX, 300) broadly transverse; cephalic margin truncate or slightly concave; epipharyngeal region with about five transverse interrupted rows of . Mentum (Plate LIX, 302) of two entirely separated plates, each half with four teeth, at the ends the smallest, the outermost tooth tending to be reduced, the two middle of each side notably larger than the others; outside of mentum a thin plate, its inner mal margins nearly contiguous at median line of body. Hypopharynx labriform, pro- ıg beyond level of both labrum and mentum; outer lateral angles densely hairy, an posterior area with about eight small, hyaline spines. Antenna (Plate LIX, 301), in ic-potash mounts, hyaline; basal segment elongate-cylindrical, bearing at its tip about papillae as follows: a long, slightly curved, cylindrical papilla which is finely sculptured, mmediately proximad of this a slightly smaller second segment of the antenna, bearing its tip three tiny papillae, an inner flattened subspatulate blade, and two longer cylin- l papillae; near base of this second antennal segment a long seta. Mandible (Plate LIX, rather long and slender, apical point narrow; about four small lateral teeth near ventral ıg edge, the most basad of these acute; a large dorsal tooth on cutting edge and two small acute teeth near base; on dorsal face of mandible two long setae, and two what shorter setae near heel of mandible; about five or six stout setae at prosthecal n. Maxilla (Plate LIX, 304) consisting of two elongated lobes which are separate from other, the outermost the longer, the pale rounded palpus terminal in position; inner shorter, with three elongate setae, of which one is apical and the longest is sub-basal in ion.

pa.— Length, 4.5–4.7 mm.
Depth, d.-v., 0.8 mm.

lor light yellowish brown, the thoracic dorsum paler; pronotal breathing horns dark n, apical quarter abruptly light yellow; abdomen brown, lateral and posterior parts ch segment darker.

phalic crest small, each lobe with three small setiferous punctures on anterior face; ad of crest between antennal bases a prominent median lobe. Labrum broad; apex ated, indistinctly bifid. Labial lobes large, with a deep U-shaped median notch behind. llary palpi rather short and stout, ending before joint of fore legs (Plate LX, 307). otal breathing horns moderately elongate, curved slightly laterad, strongly divergent, lrical, of uniform diameter thruout their length. Mesonotum not very gibbous (Plate 306). Thorax with a high anterior median carina. Wing sheaths extending beyond of third abdominal segment, the venation indistinct. Leg sheaths rather long, ending out one-third length of fifth abdominal segment; hind legs much longer than the s, middle legs a very little longer than fore legs.

dominal segments indistinctly subdivided into two rings, a narrow anterior ring and a broader posterior ring; abdominal armature very weak, lacking on segment 7; basal us on tergites and sternites with a number of small pits on sides, these sometimes sparse cking; posterior ring with a transverse row of numerous long, stout setae or delicate s before margin. Spiracles weak, at base of posterior ring. Male cauda (Plate LX, nd 310) with sternal lobes elongate, contiguous except at extreme tips; tergal lobes nating in very slender and acute curved points, directed caudad and dorsad; tergite

8 swollen, with four blunt lobes, the posterior pair large, with their posterior faces setiferou Female cauda (Plate LX, 308) with sternal valves much shorter than tergal valves and rath blunt at tips; tergal valves broad at base, narrowed at tips, which terminate in acute bla spines, situated on lateral margin before apex, the spines directed dorsad, laterad, and cauda

The larvae were common near Ithaca, New York, from May 10 t June 5, 1917. The pupae are described from one male and two fema washed from mud from Bool's hillside, at Ithaca, on June 11, 1917. little later in June adult flies of this species were common at this locatio

Adelphomyia americana Alex. (supposition)

1912 *Adelphomyia americana* Alex. Pomona Journ. Ent., vol. 4, p. 829–831.

Larvae that were rather common in the rich organic mud from th Standpipe Woods, Orono, Maine, from July 1 to 14, 1913, are referre with some doubt to *Adelphomyia americana*. They are unquestionabl congeneric with the species last described (*A. minuta*, supposition) ar with the form discussed in the following pages as *A. cayuga*. A sho time after the larvae of these three species were obtained, the adult fli appeared in considerable numbers in the same situations and there seem to be but little doubt as to the reference. Associated with the larva of this species in the organic mud were a few larvae of Penthoptera Rhaphidolabis, and other species of crane-flies.

The larva of the present species averages larger than that of *A. minut* when fully grown measuring 5.5 millimeters in length. In coloratio it is light yellow. The ventral lobes of the spiracular disk have the dar markings on their inner face much more extensive, the apical half bein suffused with brown. The mouth parts are similar to those of *A. minut* as described, but the outermost of the two large teeth of each half of th mentum is reduced in size so that only a single tooth is of conspicuous size

(Described from larvae taken at Orono, Maine. No. 66–1913.)

Adelphomyia cayuga Alex. (supposition)

1912 *Adelphomyia cayuga* Alex. Pomona Journ. Ent., vol. 4, p. 831.

The supposed larva of *Adelphomyia cayuga* occurred with specimen of the preceding (*A. americana*, supposition) at Orono, Maine, from Jul 1 to 13, 1913. This is a smaller species than the preceding, measurin but 4 millimeters in length, and is much paler, the color being almos

te. The condition of the mental teeth is almost as in *A. americana*, the outermost of the two large intermediate teeth is a little larger. larvae were rather frequent in the mud beneath saturated moss. Described from larvae taken at Orono, Maine. Nos. 57– and 67–1913.)

Subtribe **Pedicaria**

he Pedicaria comprise a well-defined division of the tribe Pediciini, uding two groups of genera — the more generalized Pediciae, with genera Pedicia, Tricyphona, Ornithodes, and Rhaphidolabina, and specialized Dicranotae, with the genera Dicranota, Rhaphidolabis, probably Polyangaeus.

he genera of the Pedicaria may be divided in the main as follows:

Larvae

odomen without prolegs, but with raised welts on segments 4 to 7, these covered with a microscopic scurfiness. (Group *Pediciae*) 2
odomen with conspicuous cylindrical prolegs on segments 3 to 7, these with circlets of conspicuous chitinized hooklets around their ends ..... Group *Dicranotae* (p. 906)
odominal segments 4 to 7 with raised welts on both dorsal and ventral surfaces; sides of hypopharynx not parallel, narrowed toward base ..... *Rhaphidolabina* Alex. (p. 901)
odominal segments 4 to 7 with welts on ventral surface only; sides of hypopharynx subparallel 3
ze very large, when fully grown 40 mm. in length; mental plates without a small lateral tooth ..... *Pedicia* Latr. (p. 899)
ze smaller, when fully grown under 30 mm. in length; mental plates with a small lateral tooth ..... *Tricyphona* Zett. (p. 903)

he writer is unable to separate the genera of the group Dicranotae the material available, and is inclined to suspect the congenerousness Rhaphidolabis with Dicranota. The characters given by Malloch 5–17 b: 217) to separate the two genera do not hold at all in a series. is impossible also to key the pupae with the present knowledge of group.

p **Pediciae**

us **Pedicia** Latreille (Gr. *a field*)

809 *Pedicia* Latr. Hist. Nat. Crust. et Ins., vol. 4, p. 255.
916 *Daimiotipula* Matsumura. Thous. Ins. Japan, add. 2, p. 463.

edicia is a small genus including but six described species, one occurring urope, one in Japan, and four in North America. Of the last-named,

two are eastern and two are western in their distribution. They inclu the largest and most beautiful species of the Limnobiinae.

The European *Pedicia rivosa* (Linn.) was found by Beling (1879:45 4 living in brooks and springs, or in wet spots among saturated leaves a other débris, sometimes associated with the larvae of *Tipula lutesce* Fabr. The pupae live in cylindrical vertical burrows, clothed in t last larval skin, and are able to move up and down in these passag Pupation lasts from one to two weeks.

Needham (1903:285–286, and 1905:8) was the first to describe a figure the larva of the commonest eastern species, *Pedicia albivitta* Wa

Pedicia albivitta Walk.

1848 *Pedicia albivitta* Walk. List Dipt. Brit. Mus., vol. 1, p. 37.

Pedicia albivitta is a beautiful fly, common and widely distribute thruout the northeastern United States and Canada. The adults a on the wing in midsummer, and a few individuals may usually be foun in June. The much rarer and more local *P. contermina* Walk. is a vern species, on the wing in May and early June.

The larvae of *P. albivitta* live in cold springs and beneath saturate moss at the edge of streams. The writer has never succeeded in rearin this species to the adult condition.

Larva.— Length, 40–44 mm.
Diameter, 5–5.5 mm.

Color dark grayish brown above, paler at sutures and on posterior half of body; pal beneath, more grayish.

Body covered with a short, appressed, dusky pubescence. Thoracic segments with pencil of small setae on pleural region. Abdominal segments with a few delicate later setae on posterior ring, at about midlength of segments. Ventral creeping-welts on abdomin segments 4 to 7 completely divided on median line, the welts covered with a microscop scurfiness. Spiracles (Plate LXI, 311) circular, separated by a distance about equal diameter of one, situated on a slightly protuberant elevation. Spiracular lobes two, ventr in position, short, slender, each with about six setae at tip. Anal gills (Plate LXI, 31 short, stout at base, before tip a constriction cutting off the elongate conical termin segment, which is partly telescopic within the next basal segment.

Head capsule (Plate LXI, 312) massive, elongate, as in this division. Labrum broad transverse, lateral parts a little enlarged and projecting anteriorly into blunt lobes, with long seta near inner margin; median region of labrum with two widely separated setae, ju laterad of each of which is a small papilla. Epipharynx roughened into a narrow transver band of small spines. Mentum completely divided, each half continuous with ventral pla

ne side; anterior margin of each half with three slender, flattened teeth, the middle one ich is slightly the shortest. Hypopharynx conspicuous, labriform; anterior margin with o notch to form distinct lobes at lateral angles, and with several rows of small chitinized cies. Antenna (Plate LXI, 313) small; basal segment elongated, slightly curved, a ar auditory plate near base, at tip with numerous papillae, two of which are very long, as long as segment itself; in addition to these, three or four tiny cylindrical papillae. libie powerful; ventral cutting edge with a row of about four teeth which are succes- enlarged from tip to base; basal tooth very broad and flat, with outer margin truncate ghtly concave; teeth on dorsal cutting edge indistinct; a pencil of moderately delicate on scrobal region of mandible, and another at prosthecal region. Maxilla elongate; lobe larger than inner lobe, chitinized, apex with a very flat circular palpus (Plate 314) which is provided with a few disklike papillae around margin and a few scattered y papillae over pale apex; inner lobe with a long, powerful seta on ventral face and er setae near tip.

pionotype.— Ithaca, New York, June 1, 1917.
ratypes.— Larvae from type locality.

us Rhaphidolabina Alexander (Gr. diminutive of *Rhaphidolabis*)

016 *Rhaphidolabina* Alex. Proc. Acad. Nat. Sci. Phila., p. 540–541.

va.— Body covered with an abundant, appressed pubescence and tufts of erect hairs are more numerous on anterior end of body. Creeping-welts on dorsal and ventral es of abdominal segments 4 to 7. Spiracular lobes two, moderately elongated, each about six hairs at tip. Spiracles large. Anal gills four, long and diaphanous. Head le long and massive. Mandible powerful. Antenna short, with two elongate papillae. pharynx labriform, anterior margin concave. Mentum completely divided, each half hree large teeth and a much smaller lateral tooth.

pa.— Labrum truncate. Pronotal breathing horns short-cylindrical or slightly flattened. minal segments with circular areas of spicules on pleurites. Intermediate tergites with d transverse band of tiny spines.

ne genus Rhaphidolabina includes only *R. flaveola*, a curious pallid f the northeastern United States, serving as a connecting link between yphona on the one hand and the Dicranotae on the other. The flies are common on rank vegetation in cold woods. The immature s are spent in rich organic earth in the same situations as are fre- ted by the adult flies.

hidolabina flaveola (O. S.)

869 *Rhaphidolabis flaveola* O. S. Mon. Dipt. N. Amer., part 4, p. 288.

e writer has found the larvae of *Rhaphidolabina flaveola* in Maine n New York. At Orono, Maine, larvae were numerous in the rich

organic mud of the Standpipe Woods. One large larva was placed a watch crystal with a fully grown larva of *Adelphomyia cayuga* (suppo tion). It at once seized the latter in its mandibles at about the th abdominal segment, and carried it helplessly all around the di occasionally shaking it, quite as a terrier does a rat.

Larva.— Length, 9.8 mm.
Diameter, 0.8 mm.

Color, brown to orange-yellow on anterior segments of body, becoming darker on abdom segments due to the increase of pubescence.

Body covered with an abundant, appressed pubescence. Form terete; body modera elongated, gradually narrowed toward both ends. Abdominal segments 2 to 8 div into a narrow basal ring and a much broader posterior ring; segments 4 to 7 with conspicu dorsal and ventral welts, which are larger and more conspicuous on posterior segm these welts occupying basal ring of segments, and bisected by a deep longitudinal med impression, their surface covered with microscopic points. Thoracic segments before m length with a transverse row of stiff, dark brown hairs grouped in tufts or pencils; th hairs occurring on abdominal segments also, but less prominent here and occupying poste region of segments; pencils more numerous on ventral and pleural regions, much scant on dorsal surface except on pronotum. On sides of last abdominal segment, between spira and spiracular lobes, several long setae arranged in a transverse row, lacking on mid-do and ventral regions. Spiracular disk (Plate LXII, 321) reduced to two ventral lobes, a this division, these lobes slightly united basally, not very elongate, blunt at their tips, wh bear about six dark setae. The two spiracles large and conspicuous, entirely exposed dorsum of last segment, separated by a distance a little less than diameter of one; mid piece of spiracles large, black; ring brownish yellow. Anal gills four, long and slender, nea hyaline, divided into lobes by slight constrictions; posterior pair of lobes a little longer th anterior pair.

Head capsule elongate, flattened, massive, as in this tribe. Labrum conspicuous, exce ing mentum and hypopharynx, the anterior margin fringed with long hairs. Ment (Plate LXII, 316) completely divided, each half with three subequal prominent teeth a an additional much smaller lateral tooth; middle tooth of each side a little broader. Hy pharynx (Plate LXII, 317) labriform, anterior margin deeply concave, roughened. Ante (Plate LXII, 318) short, the segment short-cylindrical, a little enlarged toward trunca apex; at tip several papillae, of which two are exceedingly elongate, very slender, about tw length of basal segment. Mandible (Plate LXII, 319) powerful, ending in an acute poi ventral cutting edge with about four teeth, the basal one of which is the largest, subtrunc the next outer tooth a large, flattened, acute blade, two or three smaller flattened teeth j before tip; dorsal cutting edge with about two small teeth. Maxilla (Plate LXII, 3 short and very stout, the outer lobe much longer than the slightly smaller inner lobe.

Pupa.— (The following notes are taken from the cast pupal skins of the bred specime Labrum truncate. Labial lobes ovate. Maxillary palpi short and stout, broadest j beyond base, tips blunt (Plate LXII, 322). Antenna moderate in length, tapering gra ally to tip. Pronotal breathing horn (Plate LXII, 323 and 324) short, cylindrical

tly flattened, with a row of circular breathing pores along margin of distal end, which ghtly enlarged. Wing sheaths short. Leg sheaths much longer.
eural region of abdominal segments with circular areas which are armed with abundant, t, straight or slightly arcuated, rows of spicules, there being from five to seven spicules ach row; under high magnification these appearing as flattened, scalelike tubercles, ed with the spicules described above; dorsum of intermediate abdominal segments a broad transverse band which is rather densely set with tiny, sharply curved spines; osterior segments these rows lacking or much weaker; dorsal bands lying posterior to of lateral areas. Male cauda (Plate LXII, 325) with dorsal plate rather small, each indistinctly bilobed at tip; outer lobe minutely tuberculate and with a small seta; ral lobes large, blunt at tips; eighth tergite on either side with a small tubercle bearing setae.

epionotype.— Ithaca, New York, May 14, 1917.
eanotype.— Ithaca, May 26, 1917. Cast pupal skin; larva placed in rearing May 14, , emerged May 26, male.
ratypes.— Larvae, with type larva. Pupae, taken as larvae May 27, 1917, placed in ng, emerged June 7, 1917. No. 79 - 1917.

us **Tricyphona** Zetterstedt (Gr. *three* + *bend*)

1837 *Tricyphona* Zett. Isis von Oken, p. 65.
1856 *Amalopis* Hal. Ins. Brit., Dipt., vol. 3, p. 15.
1856 *Bophrosia* Rond. Dipt. Ital. Prodr., vol. 1, p. 183.
1860 *Crunobia* Kol. Wien. Ent. Monatschr., vol. 4, p. 391.
1881 *Nasiterna* Wall. Ent. Tidskr., vol. 2, p. 179, 191.

va.— Body moderately elongate, with ventral transverse creeping-welts on basal annuli dominal segments 4 to 7. Spiracular lobes two, moderately elongate. Anal gills four, ed into two to four lobes by from one to three constrictions. Head capsule massive, ate. Eyespots distinct. Mandible powerful, ending in an acute point and with about lateral teeth. Maxilla stout, consisting of two distinct lobes, the slender inner lobe y approximated to the larger outer lobe. Antenna small; basal segment cylindrical , with two exceedingly long, hyaline papillae (possibly lacking in *T. immaculata*). pharynx labriform, anterior margin concave, roughened. Mentum completely divided, ior margin of each half with three large teeth.
pa.— Pronotal breathing horns short and stout, blunt, angles rounded. Abdominal ents with transverse bands of spicules on tergites and sternites, and circular areas eurites.

ricyphona is the largest genus of the Pediciini, including more than described species. Almost all of these species are found in the rctic region, but two or three are Antipodal. In the eastern United es, *Tricyphona inconstans* is the most widely distributed and appar- the commonest species. This species and certain others (as *T. dicola* Alex.) are characteristic swamp inhabitants, but other species

occur along running streams (*T. vernalis* [O. S.]) or near cliffs (*T. auripenn* [O. S.]).

The immature stages of the known species are usually spent in moi earth. In Europe, *T. immaculata* (Meig.) was reared by Beling (1879:4 from larvae taken beneath decaying vegetable mold in the bed of dried-up woodland stream. Other specimens were found in old hor manure in beech woods. De Meijere (1916:195-196) found the sa species in decaying leaves and other vegetable matter in wet spots ne the banks of streams. *T. schineri* (Kol.) was found on August 19 in wet spot in beech woods, where the larvae were associated with pup of *Pedicia rivosa* in damp earth beneath 'débris,' adults emerging September 6 and 12 (Beling, 1879:47). The only American spec whose immature stages have been found is *T. inconstans*, descril herein.

Tricyphona immaculata (Meig.), the genotype, as described by M Meijere in the paper cited above, differs from *T. inconstans* as here described in the following points: The antenna bears a very short termi papilla instead of the two very long ones in the local species. The sm lateral tooth on the mentum is not mentioned nor figured as appeari in *T. immaculata*. The anal gills are short and with but a single co striction. The pupa has the pronotal breathing horns small, kidne shaped, the outer margin rounded. The fore legs are a little shorter th the middle legs, and these in turn are somewhat shorter than the posteri legs. The skin of the abdomen is very delicate, with crossrows of ve small spicules, arranged in numerous irregular transverse rows, at t posterior margins of the segments, about seven such crossrows bei present.

Tricyphona inconstans (O. S.)

1859 *Amalopis inconstans* O. S. Proc. Acad. Nat. Sci. Phila., p. 247.

Tricyphona inconstans is an abundant species thruout eastern Nor America. It has been recorded also from Europe, but the latter recor are almost certainly erroneous. The writer found larvae of this spec in rich mud at Larch Meadows, near Ithaca, New York, on May 1 1917, in association with larvae of *Rhamphidia mainensis*, *Pseudolimnoph luteipennis*, and *P. inornata*. Adults emerged on May 27, 1917 (N 52-1917). An account of the association in which these larvae occur

ven in connection with the discussion of *Rhamphidia mainensis* 831).

a.— Length, 17–17.5 mm.
Diameter, 1.3 mm.

or pale yellowish white; anterior parts of body sometimes a more saturated yellow. moderately stout, body a little narrowed toward ends; surface of body almost us, the vestiture being a microscopic pale pubescence and scanty scattered hairs. al surface of abdominal segments 4 to 7 with a prominent transverse welt, which is ed out medially so as to appear as paired prolegs, these being unarmed with hooks nts. Spiracular lobes short, divergent, tapering gradually to the blunt tips, which are ed with seven or eight setae. Spiracles (Plate LXIII, 330) on a transverse oval eleva- mall, rounded, separated by a distance greater than diameter of one; middle piece of es large, black, rings narrow. Anal gills four, very long and slender, constricted bout four lobes which are successively narrowed from the base outward, the terminal n very slender.

d capsule of the usual elongate, massive type of this tribe. Labrum large, projecting d hypopharynx, anterior margin with long hairs. Mentum (Plate LXIII, 326) large, etely divided, each half with three subequal narrow teeth and an additional reduced tooth; on proximal margin of each half of mentum, near base of innermost tooth, tiny notches dovetailing into those of opposite half. Hypopharynx (Plate LXIII, 327) ing far beyond mentum, labriform; anterior margin deeply concave and provided with rounded papillae; lateral angles smooth, rounded, subchitinized. Antenna (Plate , 328) small; basal segment cylindrical, bearing at its tip two elongate papillae which out one-half longer than basal segment alone; besides these an oval papilla. Mandible LXIII, 329) of the usual pediciine type, powerful, the apex running out in a long, point; ventral cutting edge very flat, cut into about five teeth, the two basal of which y large; the most basal of these teeth squarely truncated, the left mandible with an nal small tooth on lower inner angle of this blade; the next outer tooth rather acute; ost teeth small and flattened; dorsal cutting edge, as usual with this division, with ry small teeth located far out on apical point; a tuft of a few long setae on back of le near heel. Maxilla (Plate LXIII, 329) powerful, as in this group of genera, t exserted from the prothoracic orifice when head is retracted; outer lobe very feebly chitinized basally, hyaline at apex, which bears the flattened, disklike palpus; obe slenderer, shorter, with a few setae and small papillae.

a.— (The following notes are taken from the cast skins of the reared specimens.) um with apex broadly triangular. Labial lobes large, ovate, tips narrowed and rounded (Plate LXIII, 331). Pronotal breathing horns (Plate LXIII, 332 and 333) ort, stout, roughly cylindrical, the apices truncated; in lateral outline, pentagonal, row of breathing pores around margin of truncate apex. Thoracic dorsum trans- roughened by short, irregular grooves.

minal sternites with broad transverse bands of spicules on segments 5 to 7, the last e three bands the weakest; similar bands on tergites 4 and 5, these bands subequal pleural region with a large, roughly circular area of short rows of microscopic spicules,

these areas near base of segments. Female cauda (Plate LXIII, 334) with tergal val elongate, tapering gradually to the rather blunt tips; sternal valves very small, blunt at t at base, on dorsal side of eighth segment, two setiferous tubercles.

Nepionotype.— Larch Meadows, Ithaca, New York, May 15, 1917. No. 52-1917.
Neanotype.— Ithaca, May 27, 1917, a cast pupal skin.

Group **Dicranotae**

Genus **Dicranota** Zetterstedt (Gr. *a fork*)

1838 *Dicranota* Zett. Ins. Lapponica, Dipt., p. 851, no. 164.

Dicranota is a small genus of crane-flies (about fifteen described spec occurring thruout the Holarctic region. Four species are found in east North America. None of the American species have been reared. Europe, the life history and morphology of *Dicranota bimaculata* (Schu has been discussed in detail by Miall (1893) and by Wesenberg-Lu (1915:342–343). Larvae were found by Miall in numbers in the mud banks of small streams and ponds, where they bury themselves in t mud and gravel. They creep about with ease and rapidity between t sand and gravel, and are able to swim well by a looping movement. Th food consists largely of small worms, *Tubifex rivulorum* Lam., wh abound in these haunts. The pupal stage is passed in damp earth. T larva is stated to be about 18 millimeters in length, but this seems to a maximum figure. The body is dirty white in color and is covered w fine, appressed hairs. Abdominal segments 3 to 7 bear paired retract pseudopods, which are circled with three rows of chitinized hooks gradua decreasing in size from the tips inward. The anal gills, four in numb are distinctly segmented. The head capsule is elongate and massi as in the tribe. The mentum is completely divided, its anterior mar having the usual six teeth. The mandible is of the usual pediciine ty with acute teeth on the ventral cutting edge and a brush of hairs n the prosthecal region. (Plate LXIV.)

The pupa is small, only about 10 millimeters in length, and has t pronotal breathing horns expanded and flattened at the tips. The dor surface of the abdomen is provided with roughened plates armed w rather strong and dense spines, there being one such plate on the th segment, two on the fourth to sixth segments, and one on the seve segment.

us **Rhaphidolabis** Osten Sacken (Gr. *needle* + *forceps*)

869 *Rhaphidolabis* O. S. Mon. Dipt. N. Amer., part 4, p. 284–287.
911 *Cladurοides* Brun. Rec. Indian Mus., vol. 6, p. 288.

haphidolabis is a small genus, including about fifteen described species ing thruout the North Temperate Zone. The larvae strongly resemble e of Dicranota, and the two genera are undoubtedly very closely ed.

phidolabis tenuipes O. S.

869 *Rhaphidolabis tenuipes* O. S. Mon. Dipt. N. Amer., part 4, p. 287.

eedham (1908a:212–214) found adult flies of the species *Rhaphidolabis ipes* in great numbers in tent traps set over Beaver Meadow Brook he Adirondacks in July and August, 1907. Larvae that almost cer- ly belong here were found among the rounded stones in the creek om.

va.— Length excluding caudal lobes, 8–9 mm.
Length of caudal lobes, 1 mm.

dominal segments 3 to 7 with prominent fleshy prolongations on ventral surface, these retractile, unpaired, and widely separated on mid-ventral line, and bearing at tip a t of outcurved hooklets, with series of smaller hooklets beyond. Spiracular disk with wo ventral lobes long and obtuse at tips. (Further details are given by Needham.)

phidolabis cayuga Alex. (supposition)

916 *Rhaphidolabis cayuga* Alex. Proc. Acad. Nat. Sci. Phila., p. 543–544.

arvae which the writer refers to this species were found in Needham's , Ithaca, New York, on March 30, 1916. Later in the season, in l and May, adult flies of the species are very numerous in this glen, these account for the specific reference.

va.— Agreeing very closely with descriptions of both Dicranota and *Rhaphidolabis ies.* Spiracles large, lying in a distinct longitudinal groove, by the closing of which they apable of being entirely hidden. Antenna long and slender, tapering to apex, which numerous short papillae. Mandible with third lateral tooth of ventral cutting ery long and acute, much exceeding second tooth; basal tooth shaped like a prun- ife, with the cutting edge sinuate; at prosthecal region of mandible, a small tuft of seven or eight long setae. Maxilla having the two lobes firmly united except on quarter.

Tribe Eriopterini

The tribe Eriopterini comprises a vast assemblage of usually small crar flies whose geographical range is coextensive with that of the family.

The larvae, so far as known, are herbivorous. They show a remarkal uniformity in the structure of the head capsule. In the generaliz members such as Molophilus and some Erioptera, the ventral bars of t head capsule are toothed at their anterior ends and form mental pla which are apparently homologous with those of the Pediciini. In Chio an apparently similar condition exists, to judge from Brauer's figu In the majority of species, however, the ventral bars of the capsule a not enlarged nor toothed anteriorly and do not function as the men plates. The hypopharynx is preserved as a hemispherical cushion wh is densely provided with setae. The mandibles are small and are blu at their tips; the teeth of the cutting edge are usually three in numb and blunt, but in some species (Ormosia, Gonomyia) they are long and more prominent. A distinct prostheeal lobe or hook is usua developed, and near the base of the mandible is a slitlike opening beari a fringe of long, yellow setae. The maxillae are rather large, hairy lob The labrum and epipharynx is long and narrow, and densely hairy. T antennae are remarkably uniform thruout the group, consisting of a sto cylindrical basal segment with a slightly smaller apical papilla of elongate-oval shape. In the Elephantomyaria the condition is somewh similar, the mandibles being very small, and the esophageal region bei conspicuously grooved with parallel lines and ridges. The spiracu disk is obliquely truncated and indistinctly lobed in Chionea and Teuch labis; surrounded by four lobes in Elephantomyia; squarely truncat and surrounded by four (in Rhabdomastix) or usually five lobes. the undetermined Eriopterine No. 1, the five lobes are spatulate flatten blades with the margins hooked. Anal gills are usually present a variously developed in the different genera. The pupa is rather slend in the Elephantomyaria with the rostral sheath very long and the pa strongly recurved. The head usually bears a small setiferous crest whi is rarely lacking. The pronotal breathing horns vary considerably form and relative size, being flattened into fans in some Gonomyia, sm and trumpet-shaped in other Gonomyia and in Gnophomyia, elonga in most species. The mesonotum is usually armed at the crest with spin hooks, or setiferous tubercles. The leg sheaths are very short in G

nyia but are longer in other genera, and the middle tarsi are usually ter than the other legs. The abdominal segments are subdivided two rings, the posterior ring with a transverse row of spines and e before the margin. The lateral spiracles are small, protuberant, in some cases at least, apparently functional. The dorsum of the h abdominal segment is provided with four or five lobes, which are me cases (as in some Ormosia) spinous at the tips.

ne writer has subdivided the tribe Eriopterini into two divisions: Elephantomyaria, with Elephantomyia and presumably Toxorhina Ceratocheilus, and the Eriopteraria, including the other Nearctic ra as known. It is probable that Cladura and its relatives will require vision when their immature stages are better known.

ne genera of the tribe Eriopterini may be separated by the following :

Larvae

piracular disk surrounded by four lobes 2
piracular disk not as above 3
entral lobes with a single powerful seta; coloration a saturated golden yellow; lives under bark ..... *Elephantomyia* O. S. (p. 952)
entral lobes fringed with short setae; coloration pale yellow; lives in earth. *Rhabdomastix* Sk. (p. 942)
piracular disk obliquely truncated, appearing indistinctly trilobed or without lobes ... 4
piracular disk squarely truncated, surrounded by five lobes 5
Iandibles with eight teeth; mental plates with seven teeth; lives in earth. *Chionea* Dalman (p. 950)
Iandibles with less than eight teeth; mental plates not toothed; lives under bark. *Teucholabis* O. S. (p. 945)
piracular disk ending in five flattened black plates which are finely toothed along their margins ..... *Genus incertus*, Eriopterine No. 1 (p. 956)
piracular disk not as above 6
entral plates of head capsule expanded and toothed at anterior ends 7
entral plates not toothed as above 8
entral plates with four teeth; coloration yellow; spiracular disk large, very heavily marked with black ..... *Molophilus* Curt. (p. 911)
entral plates with five to eight teeth; coloration green; spiracular disk very reduced, almost unmarked ..... *Erioptera* (*chlorophylla* O. S.) (p. 918)
Iarks of all the lobes solidly black ..... *Trimicra* O. S. (p. 932)
Some *Ormosia* Rond. (p. 922)
me of the marks more or less split by a pale line 9
ne three dorsal lobes solidly dark, the ventral pair split by a pale line 10
l paired lobes split by a pale line 11
oloration saturated yellow; anal gills bluntly rounded; lives under bark. *Gnophomyia* O. S. (p. 934)
oloration pale yellow; anal gills elongate; lives in earth. *Helobia* St. Farg. et Serv. (p. 928)
obes surrounding disk very stout, blunt; marks of lateral lobes surrounding spiracles and often suffusing disk ..... *Gonomyia* Meig., subgenus *Leiponeura* Skuse (p. 939)
obes surrounding disk longer; marks of lobes not so extensive 12

12. All the lobes with two lines.....
Dorsal lobe solidly dark.....Some *Ormosia* Rond. (p. 92
13. No dark marks on disk between spiracles.....Some *Ormosia* Rond. (p. 92
Dark marks between spiracles.....
14. Spiracular disk very small; two spots on disk...*Erioptera* (*megophthalma* Alex.) (p. 91
Spiracular disk large; four or six spots on disk.....*Helobia* St. Farg. et Serv. (p. 92

Pupae

1. Rostral sheath very elongated; antennal sheaths lying across face of eye.
Elephantomyia O. S. (p. 95
Rostral sheath not elongated; antennal sheaths lying behind eyes.....
2. Leg sheaths very short, barely exceeding wings; crest of mesonotum smooth or nearly
Gnophomyia O. S. (p. 9
Leg sheaths longer, ending about one segment beyond end of wings; crest of mesonot
with spines or tubercles.....
3. Mesonotum at crest with numerous sharp spines; hind tarsi the longest, middle tarsi
shortest, fore tarsi intermediate in length.....*Helobia* St. Farg. et Serv. (p. 9
Mesonotum and tarsal arrangement not as above.....
4. Mesonotum at crest with six to eight tubercles provided with numerous setae; breathi
horns fanlike or trumpet-like.....*Gonomyia* Meig. (p. 93
Mesonotum and breathing horns not as above.....
5. Mesonotum at crest with four sharp spines or two plates produced into spines.....
Mesonotum at crest without distinct prominent spines.....
6. Mesonotum at crest with four spines.....
Mesonotum at crest with a plate on either side split at tip into three or four teeth.
Ormosia (*nubila* [O. S.]) (p. 92
7. Crest of mesonotum with two large spines; pronotal breathing horns small, closely appli
to thorax; lives under bark.....*Teucholabis* O. S. (p. 94
Crest of mesonotum with four large spines; pronotal breathing horns long, slender, curv
lives in earth.....*Molophilus* Curt. (p. 91
8. Abdominal pleurites with a transverse subterminal row of from eight to twelve spines
stout setae; dorsum of segment 8 with a pentagon of five lobes.
Ormosia Rond. (p. 92
Abdominal pleurites without such a row of spines or setae; dorsum of segment 8 with fo
or fewer lobes.....*Erioptera* Meig. (p. 91

The most important literature on the tribe Eriopterini is as follows:

Molophilus bifilatus	Larva, general	Keilin, 1913:4. (Hypoderm glands.)
Molophilus obscurus	General	Beling, 1879 56.
Molophilus ochraceus	Larva, pupa	Beling, 1886:193–194.
Erioptera maculata	Pupa	Beling, 1879:49.
Erioptera flavescens	Larva	Beling, 1879:50.
Erioptera lutea	Larva, pupa	Beling, 1886:192–193.
Erioptera sordida	General	Beling, 1879:56.
Cheilotrichia imbuta	General	De Meijere, 1920:76.
Lipsothrix icterica	Larva, pupa	Beling, 1886:192.
Ormosia haemorrhoidalis	Pupa	Beling, 1879:48–49.
Ormosia haemorrhoidalis	Larva, pupa	Beling, 1886:191–192.
Ormosia lineata	General	Beling, 1886:202.
Ormosia nodulosa	General	Beling, 1886:202.
Ormosia nodulosa	General	Cameron, 1917:65.
Ormosia varia	Larva, pupa	De Meijere, 1916:201–204.

hybrida	Larva, pupa	Beling, 1879:50–51.
hybrida	Larva	Hart, 1898 [1895]:199–200.
hybrida	Larva, pupa	Malloch, 1915–17b:229–230.
i pilipes	Larva, general	Gerbig, 1913:161–163.
nyia rufa	Larva, pupa	Hudson, 1920:32–33.
nyia tripudians	General	Gamkrelidze, 1913, a and b.
nyia tripudians	General	Keilin, 1913:3. (Hypodermal glands.)
nyia tripudians	Larva	Keilin, 1913:4. (Hypodermal glands.)
nyia tripudians	General	Edwards, 1919 b.
nyia tristissima	Larva, pupa, general	Malloch, 1915–17b:230–231.
ia tenella	General	Beling, 1879:56.
nastix schistacea	Larva, pupa	Beling, 1886:195.
phlia bromeliadicola	Larva, pupa, general	Picado, 1913:356–357.
phlia leucoxena	General	Alexander, 1915 b.
phlia pennipes	Larva, pupa, general	De Meijere, 1911:50–51.
ibis complexa	General	Johnson, 1900.
araneoides	Larva, general	Brauer, Egger, and Frauenfeld, 1854.

Subtribe **Eriopteraria**

Molophilus Curtis (derivation obscure)

3 *Molophilus* Curt. Brit. Ent., p. 444.

— Form long and slender. Spiracular disk squarely truncated and surrounded by equal lobes; paired lobes of disk heavily lined with black; a black mark running proximal spiracles; dorsal lobe with an oval black area. Head capsule long and narrow; rods flattened; anterior ends expanded, four-toothed, to form mental plates. narrow, densely hairy. Mandible blunt at apex; ventral cutting edge with about th; a single subapical dorsal tooth. Maxilla large and blunt. Antenna large; apical elongate-oval, sculptured.

— Cephalic crest setiferous. Pronotal breathing horns long and slender, sinuously Mesonotum declivitous, at crest with four powerful teeth. Wing sheaths ending midlength of second abdominal segment. Leg sheaths ending at about midlength abdominal segment; tarsi of middle legs the shortest. Abdomen with spiracles ents 2 to 7; dorsum of segment 8 with four blunt lobes.

ophilus is a well-defined genus (including more than fifty species) ll and usually dull-colored flies, which are found practically thruout rld.

adult flies frequent shaded situations and may be swept from egetation in such places. The swarming habits of this group are ed later under the specific accounts.

immature stages of the various species are spent in wet earth. ope, *Molophilus obscurus* (Meig.) (Beling, 1879:56) and *M. ochraceus* (Beling, 1886:193–194) have been found in wet earth near running

water in shaded woods. The pupal duration of the latter species is more than ten days. Keilin (1913:4) notes the presence of hypode glands in larvae of *M. bifilatus* Verr., but does not mention the h habitat. Of the American species, *M. hirtipennis* has been reared similar situations.

Molophilus hirtipennis (O. S.)

1859 *Erioptera hirtipennis* O. S. Proc. Acad. Nat. Sci. Phila., p. 228.

The little dark-colored crane-flies of the species *Molophilus hirtip* are common on vegetation in shaded woods in spring and early sum or they may be found in small dancing swarms in similar situations.

The larvae are exceedingly abundant in wet organic mud or in cool woods in the neighborhood of streams or springs. The writer has re the species very frequently from specimens found in Needham's and on Bool's hillside, Ithaca, New York, in April and May, 191 1917. The pupal period is probably about a week, but in all the rea of the writer this could not be ascertained closer than ten days.

Larva.— Length, 9–10 mm.
Diameter, 0.4–0.5 mm.

Coloration light yellow.

Form long and narrow; body terete, noticeably constricted before spiracular disk XLV, 344). Integument covered with a delicate appressed pubescence and a few tran rows of very short, erect setae. Spiracular disk (Plate LXV, 351) squarely truncate rounded by five subequal lobes; ventral lobes on inner face with two heavy black p lines, separated by a capillary yellow line; lateral lobes with a similar double line r inward far beyond spiracle; these double lines not connected at distal end; dorsal lob a single oval black mark which is less intense outwardly; a black mark beginning at s running proximad toward center of disk; lobes with a few short hairs at tips. (The little variation in the degree of intensity, but the general pattern is as described a Anal gills four, short and blunt.

Head capsule (Plate LXV, 345) long, narrow, consisting of six chitinized rods, the rods broad and flat, at the anterior end expanded to form the mental plates (Plate LX each rod contributing four teeth, of which the outermost is bluntly rounded, the midd the largest and subequal. Dorsal bars two on either side, one slender, at their a ends articulating with a transverse chitinized rod; the various bars connected by membranous tissue. Labrum and epipharynx elongate, narrow, occupying the space b mandible and antenna on either side, the ventral face with abundant long hairs, o margined with numerous long, incurved, flattened setae. Mental plates as described behind them the hypopharynx (Plate LXV, 347), consisting of a semicircular cushion p with dense, short setae. Antennae (Plate LXV, 348) rather closely approximated on d prominent, each 1-segmented but bearing a long apical papilla; basal segment mod elongated, cylindrical, the apex obliquely truncated, the papilla hyaline, gradually na

l tip, shaped somewhat like an ear of corn, the surface delicately sculptured; besides
pilla, two or three much smaller cylindrical ones. Mandible (Plate LXV, 349) slender,
in a blunt rounded lobe; ventral cutting edge with four blunt teeth, the second from
se very tiny and connected with the third from the base (in some specimens the teeth
ry blunt and rounded, so that the cutting edge appears crenulated or wavy); a single
on dorsal cutting edge, immediately behind apex; prosthecal region of mandible with
itudinal slitlike opening filled with a dense row of long setae. Maxilla (Plate LXV,
rge and blunt, the outer lobe pale, roughly triangular, covered with numerous short
and with a few small sensory papillae near apex, surrounding palpus; inner lobe a
horter, densely clothed and fringed with abundant long yellow hairs.

a.— Length, 6.2–7.3 mm.
Width, d.-s., 0.7–0.8 mm.
Depth, d.-v., 0.8–1 mm.

d, thorax, and appendages brown, when fully matured almost black; breathing horns
ish; abdomen pale yellowish white.

nalic crest of moderate size, consisting of two conical lobes directed forward and bearing
t seta on anterior face; immediately in front of these, a smaller transverse crest lying
en antennal bases. Front rather broad. Labrum triangular; lobes of labium triangular,
ent; maxillary palpi elongate, moderately stout, narrowed at tips and extending beyond
of fore legs. Thorax prominent, carinate medially before declivity. Breathing
long and slender, sinuously curved, apices directed forward. Declivity of mesonotum
LXVI, 352) precipitous, at the crest armed with four powerful teeth, median pair the
somewhat divergent, separated by median line; a few tiny setae on mesonotum, includ-
r in a transverse row at about the level of wing root. Wing sheaths ending opposite
second abdominal segment. (In fully matured pupae the characteristic venation of
nus shows on the wing pads.) Leg sheaths rather short, ending about opposite mid-
of fourth abdominal segment; hind legs slightly the longest, fore legs a little shorter,
legs conspicuously shorter, ending about opposite apex of fourth tarsal segment of
gs.

ominal segments with two very narrow basal rings and a much broader posterior
Abdominal spiracles distinct on segments 2 to 7. Setae as follows: on pleura, one
iately caudad of spiracle, a second caudad and somewhat dorsad of spiracle opposite
or ring, another opposite anterior ring. Tergum with two setae on sides of posterior
Segment 8 with four blunt lobes on dorsum. Male cauda (Plate LXVI, 353 and 354)
entral lobe large, bluntly rounded at tips; dorsal lobes ending in two acute, chitinized
which are widely separated and directed dorsad and slightly caudad, on outer face
small seta; near base of cauda on dorsum, surface tumid and bearing a small seta on
ide. Female cauda (Plate LXVI, 355 and 356) with sternal acidothecae much shorter
ie very long tergal valves, these latter, just before apex, with an acute spine which is
d dorsad and with a seta on side. (When the pupa is nearly ready to transform
adult, the long, coarse bristles covering the body of the adult, and the chitinized
a, show thru the pupal integument.)

onotype.— Ithaca, New York, May 11, 1917. No. 33–1917.
notype.— Ithaca, June 1, 1917.
types.— About one hundred larvae and pupae from type locality.

Molophilus ursinus (O. S.)

1859 *Erioptera ursina* O. S. Proc. Acad. Nat. Sci. Phila., p. 228.

Molophilus ursinus is probably the smallest crane-fly in North Ameri The following notes on the swarming were made along Power Ho Creek, Gloversville, New York, on June 27, 1915:

This species occurred in small dancing swarms over the little lateral streamlets that po down the steep slope, some of the swarms including scores of individuals. When not sw ing, they rested flat on the upper surfaces of leaves, their wings folded over the abd Crane-flies associated with this species today included the following: *Bittacomorp jonesi*, *Limnophila toxoneura*, *L. areolata*, *L. (Lasiomastix) tenuicornis*, *Liogma nodic Dolichopeza americana*, *Tipula collaris*, *T. nobilis*, *T. iroquois*, *T. hermannia*, *T. macr T. submaculata*, *T. fuliginosa*, *Nephrotoma macrocera*, *N. tenuis*, *Longurio testaceus*, and ot

Genus **Erioptera** Meigen (Gr. *wool* + *wing*)

1800 *Polymeda* Meig. Nouv. Class. Mouch., p. 14 (*nomen nudum*).
1803 *Erioptera* Meig. Illiger's Mag., vol. 2, p. 262.
1818 *Polyraphia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 88.
1854 *Octavia* Bigot. Ann. Soc. Ent. France, p. 474.
1856 *Chemalida* Rond. Dipt. Ital. Prodr., vol. 1, p. 180.
1856 *Limnaea* Rond. Dipt. Ital. Prodr., vol. 1, p. 181.
1856 *Ilisia* Rond. Dipt. Ital. Prodr., vol. 1, p. 182.
1861 *Limnoica* Rond. Dipt. Ital. Prodr., Corrigenda, vol. 4, p. 11.
1863 *Trichosticha* Schin. Wien. Ent. Monatschr., vol. 7, p. 221.
1864 *Platytoma* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 10, p. 42.

Larva.— Form elongate, in some cases very slender, terete. Spiracular disk tending be reduced, in some species (as *E. chlorophylla*) very small. Anal gills blunt. Head cap slender, consisting of six bars, four dorsal and two ventral; ventral bars in some spe (as *E. chlorophylla*), at least, with five to eight teeth at their expanded anterior end, fo the mental plates. Labrum narrow, densely hairy. Mandible small, bluntly toot Maxilla blunt, hairy. Hypopharynx cushion-like.

Pupa.— Cephalic crest consisting of blunt or acute (in *E. chlorophylla* and *E. vesper* lobes. Pronotal breathing horns elongate, the length many times the diameter, usu straight and slightly divergent (*E. megophthalma*, *E. septemtrionis*), or acutely pointed directed forward (*E. chlorophylla*). Mesonotal declivity along crest with very nume setiferous tubercles or (in the European *E. lutea*) with four prominent teeth. Leg she moderately long, reaching fourth abdominal segment; middle tarsi conspicuously sh than the others. Subapical armature of abdominal segments strong on sternites and ter but lacking on pleurites. Spiracles distinct, tubular. Lobes on dorsum of eighth abdo segment not forming a distinct pentagon.

Erioptera is a large genus of small flies, including more than one hund described species, chiefly from the temperate regions. In the case all species of which the immature stages are known, these stages are sp in wet earth. In Europe, *Erioptera* (*Acyphona*) *maculata* (Beling, 18

s found under leaves in damp earth in woods. Pupae taken on , 1874, emerged as adults on the 13th. The species was found the sandy mud of a small brook bed. *E.* (*E.*) *flavescens* (Beling, 0) was found in sandy, damp earth, *E.* (*E.*) *sordida* (Beling, 1879: ntion only) in wet, sandy earth along brooks, and *E.* (*E.*) *lutea* , 1886:192–193) in woods, in damp hollows, and along the margins ks, usually under leaf mold. Edwards (1919 a) has recorded a of Erioptera as being associated with the larvae of the mosquito hynchus at the roots of water grass (*Glyceria fluitans*) in d.

merica, *E. chlorophylla*, *E. vespertina*, *E. caloptera*, and other inhabit wet mud in open swamps; *E. septemtrionis* and *E. megoph-* rich organic mud in cool, shady woods; *E. armata*, *E.* near and other species, the soil along the sandy banks of streams. *E. ona) graphica* was considered by Hart (1898 [1895]:197) to be uatic.

writer has before him the larvae of only two species of the genus, *rophylla* and *E. megophthalma*. These are readily separated by olor, *E. chlorophylla* being pale green, *E. megophthalma* pale and more elongate. The pupae of the Nearctic species of the nay be separated by the following key:

ing horns and cephalic crest strongly pointed and curved forward at their tips; ration light green ..... *E. chlorophylla* O. S. (p. 918)
ing horns and cephalic crest not as above; coloration not green 2
ing horns elongate-cylindrical to slightly flattened, almost straight but slightly rgent, diameter subequal for entire length 3
ing horns not as above, more or less curved, or else blunt at their tips 4
lic crest sharply pointed; eyes large ..... *E. megophthalma* Alex. (p. 915)
lic crest not sharply pointed; eyes small ..... *E. septemtrionis* O. S. (p. 920)
ing horns almost straight, enlarged distally, tips blunt.
E. sp. (near *knabi* Alex.) (p. 922)
ing horns curved, narrowed toward tips 5
ing horns widely separated at base, bent strongly proximad, contiguous medially; s of cephalic crest acute, vertical; eyes large ..... *E. vespertina* O. S. (p. 919)
ing horns curved gently forward; cephalic crest with lobes directed laterad, diver- ; eyes of moderate size ..... *E. armata* O. S. (p. 921)

ra megophthalma Alex.

Erioptera megophthalma Alex. Can. Ent., vol. 50, p. 60–61.

adult flies of *Erioptera megophthalma* are not uncommon in aded, and boggy woods during the months of early spring.

They may be swept from rich vegetation in company with such c acteristic species as *Limnophila brevifurca, L. fuscovaria, L. subtenuico Adelphomyia minuta, Rhaphidolabina flaveola, Molophilus hirtipe Erioptera venusta, E. stigmatica, Gonomyia florens, G. subcinerea, Tipula oropezoides.*

The elongate larvae of this fly were very common in rich organic taken from Bool's hillside, Ithaca, New York (as discussed unde account of *Bittacomorphella jonesi*, page 780), where they were asso with a crane-fly fauna characteristic of such situations. The larva life, are pale yellowish, with the food contents, of a chalky white showing thru the integument. The head capsule and the spiracular are very small; the inner face of each lobe of the latter is very nar lined with black. The species was reared many times during late and early June, 1917, the length of the pupal existence indoors being s or eight days.

Larva.— Length, 10.4–11.6 mm.
Diameter, 0.7–0.75 mm.

Coloration very pale yellow; contents of alimentary canal chalky white.

Form ter te, elongated, body tapering gradually to the posterior end, just beyon (Plate LXVII, 358) suddenly constricted; last segment elongate-cylindrical, tapering g ally to the very small spiracular disk. Body covered with a short, appressed p cence, on last segment this pubescence coarser and more erect, with a few elongate interspersed; lateral parts of body at caudal margins of segments with short tran lines of small, erect setae; a few other similar rows at about midlength of certain segments. Spiracular disk (Plate LXVII, 357) very small, tending to be eliminat reduction; lobes short and blunt, dorso-median lobe the smallest; ventral lobes wit short brown lines, not connected distally, the proximal line a little longer than the line of each lobe; the pale space between these lines a little less than diameter o lateral lobes with two similar divergent lines, the dorsal one attaining inner le spiracles; dorsal lobe with two small, indistinct, brown lines; on disk between spirade small round spots which do not touch spiracles; lobes fringed with short hairs ne and capable of close approximation so that disk is often entirely closed. Spiracles nearly circular.

Head capsule small, very long and slender, greatly dissected, the three bars of eithe long and delicate; dorsal bars at their articulation joined with a short longitudinal ba whose anterior end the antennae are inserted; ventral bars of capsule not conspicu expanded at their anterior end, and apparently not toothed as in other species of this and in Molophilus. Labrum and epipharynx long and narrow, lying between an bases; epipharyngeal region densely clothed with short setae at tip and with two p brushes on ventral face. Mentum apparently not formed as in *E. chlorophylla*, a s

transverse chitinized bar. Hypopharynx about as in Molophilus. Antennae rather approximated, directed cephalad; basal segment moderately elongated, cylindrical; papilla relatively small, elongate-oval. Mandible very small, with blunt teeth; point short, blunt; ventral row of teeth about three in number, often very blunt. as in Molophilus, but outer lobe with the vestiture of hairs rather longer.

.— Length, 7.2–8.2 mm.
Width, d.-s., 0.8–0.9 mm.
Depth, d.-v., 1–1.1 mm.

light brown; thorax anterior to declivity conspicuously darker brown; remainder light yellowish brown; breathing horns light yellow. (In fully colored individuals d and the thorax with their appendages become much darker, almost black, but the ng horns retain their conspicuous yellow color.)

short, face tumid. Eyes of male very large, widely separated by front; eyes of smaller. Cephalic crest consisting of two prominent lobes; viewed from side, these arply pointed and directed slightly forward, with a seta on outer ventral face before ewed from front, lobes rounded, ending in acute tips, separated by a deep, rather V-shaped notch. Front between eyes narrowed toward labrum, which is rather pointed. Labial sheaths small, the lobes contiguous with their apices truncated, eral angles obtuse or produced into a tiny lobe. Sheaths of maxillary palpi short ut, tapering gradually to tips. Antennal sheaths moderately elongated, angulated ents, ending just beyond base of wing. Pronotal breathing horns stout, expanded , almost straight and only slightly divergent, somewhat compressed, transversely d basally; a small setiferous tubercle in front of base of breathing horn. Mesonotum ous, at crest (Plate LXVII, 359) on either side of median line with abundant tiny us tubercles bearing long, pale hairs, these tubercles continued back along shoulder. margin of thorax with two small setae. Wing sheaths ending before tip of second nal segment. Leg sheaths (Plate LXVII, 360) short, attaining base of fourth nal segment; tarsi of hind legs the longest, those of middle pair the shortest; fore legs mora and tibiae very short.

minal segments (Plate LXVII, 361) divided into two annuli by a constriction near gth, the anterior ring very indistinctly subdivided further into two lesser annulets; on ts 4 to 7, before caudal margin of posterior ring on both dorsum and sternum, a trans- ow of small, conspicuous, blackened, setiferous tubercles, which are more distant e another near ends of rows; on basal abdominal segments these tubercles less evident l present. Pleura with small but probably non-functional spiracles, which are very ct in young pupae but are more evident in fully colored individuals; these spiracles near base of posterior ring. Setae on abdomen as follows: on sternal segments, a just caudad of end of row of spicules, a second at lateral end of this row, inter- with spicules, two on posterior ring on a level with spicules; on tergal segments, a seta on a line with spiracles, another seta below end of row of spicules; on pleura, one t ventrad of spiracles, and two post-spiracular and one ante-spiracular setae. Male Plate LXVII, 362 and 363) with ventral lobes obliquely truncated, blunt at tips, ng beyond level of subacute dorsal lobes; dorsal lobes slender, slightly divergent , blackened before tips and with two setae at tips on outer face; at base of cauda,

on dorsal face of eighth segment, a close quadrangle of four rounded tubercles, placed a slight elevation. Female cauda with tergal acidothecae elongate, subacute at tips; ster valves short, blunt; quadrangle of tubercles on dorsum of eighth segment more disti than in the male.

Nepionotype.— Ithaca, New York, May 14, 1917.
Neanotype.— Ithaca, June 5, 1917.
Paratypes.— Larvae and pupae in large numbers from type locality, May 14 to June 1917.

Erioptera chlorophylla O. S.

1859 *Erioptera chlorophylla* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

Erioptera chlorophylla is conspicuous by its pale green color in t larval, pupal, and adult stages. It is a common and widely distribut species thruout eastern North America. Several larvae were found organic mud at Orono, Maine, on June 13, 1913, one of which pupat on the 21st. When the insect is dropped into boiling water, the gre color immediately disappears. The associates of this species are discuss under the account of *Ptychoptera rufocincta* (page 775).

Larva.— Length, 9–10 mm.
Diameter, 0.7–0.75 mm.

Color uniformly pale green, fading to a pale yellow after death.

Form moderately elongated, last segment of body elongate, gradually narrowed to blun rounded apex. Body clothed with numerous appressed hairs. Spiracular disk somewh as in *E. megophthalma* but even more reduced, disk usually entirely closed, lateral lo on either side capable of close approximation, tracheae before the opening into spirac very large.

Head capsule (Plate LXVIII, 364) of the Molophilus type, but longer and slenderer; t two dorsal bars of each side very delicate, the ventral bars broader and flattened. Men plates (Plate LXVIII, 365 and 366) slender; anterior end of each ventral bar wid expanded and provided with several teeth; these teeth varying in number, in some spe mens there being only five, in others eight, teeth to each plate; in the latter case the th from either side is larger, with two smaller teeth between. Hypopharynx about as Molophilus. Antenna (Plate LXVIII, 367) large, basal segment stout, cylindrical; api papilla elongate-oval, with apex bluntly rounded and surface weakly sculptured; laterad this papilla a tiny cylindrical hyaline peg. Mandible (Plate LXVIII, 368) rather lar cutting edge with about four slender teeth, the second from base the smallest; dorsal f of mandible with a blunt subapical tooth and an oblique comb of about six stout setae chitinized teeth. Maxilla similar to that of Molophilus, but the hairy vestiture longer a coarser.

Pupa.— Length, 8.8–9 mm.
Width, d.-s., 1.2 mm.
Depth, d.-v., 1.2 mm.

Breathing horns reddish brown; thoracic dorsum green, with a brownish tinge; domen uniformly pale green, posterior half of each dorsal segment a little darker.

Cephalic crest small and compact, consisting of two prominent but closely approximated es which are separated by a deep U-shaped notch, the tips acute and directed forward; outer face before apex a short seta. Labrum broadly obtuse at tip. Labial lobes roughly angular, divergent. Maxillary palpi short and stout, narrowed toward tip. Antennal eaths with a slender tubercle at base above eye.

Pronotal breathing horns broad at base, narrowed to the acute tip which is directed almost ntrad; viewed from above, horns very broad basally and with a dorsal carina; ventral e at base transversely wrinkled; a small setiferous lobe just in front of breathing horns, ected laterad. Mesonotum behind breathing horns with a high compressed carina, on her side of this produced into a lobe directed cephalad and laterad; mesonotum moderately clivitous (Plate LXIX, 369), at crest with numerous setiferous tubercles which are fewer number and more widely separated along shoulder. Leg sheaths reaching to about middle fourth abdominal segment; hind legs a little longer than fore legs; middle legs very short, ding opposite base of last segment of fore legs.

Abdominal segments divided into two narrow basal rings and a broad posterior ring; pleura a distinct spiracle, opposite posterior annulus and nearer dorsal margin; posterior nulus, before caudal margin, with a dorsal and a ventral row of long, stout setae. Setae abdomen as follows: on pleura, a seta opposite second basal ring, a second ventrad of racle, and two setae caudad of spiracle, the posterior one a little more dorsal in position; tergites, two stout setae lying transversely on the margin opposite spiracle, a third seta end of terminal rows of bristles; on sternites, a group of two transverse setae on posterior g, slightly below level of spiracle and rather widely separated by the broad midventral ea. Female cauda (Plate LXIX, 370) with dorsal acidothecae short, distinctly upturned, d ending in a small, subacute tip; before apex with two very short setae; a short blunt ercle near base of valves; ventral lobes short, their tips very blunt; dorsum of segment 8 h two blunt median tubercles, one immediately behind the other.

(Described from larvae taken in the Basin Swamp, Orono, Maine, June 13, 1913; one pupa h the larva, July 5, 1913.)

rioptera vespertina O. S.

1859 *Erioptera vespertina* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

Erioptera vespertina is a characteristic inhabitant of open swamps and t meadows. It has not been reared, but a pupa found in organic mud the Basin Swamp, Orono, Maine, on June 24, 1913, undoubtedly belongs this species. The associates are discussed under the account of *Bittacorpha clavipes* (page 785).

Pupa.— Length, 8.5 mm.
Depth, d.-v., 1.1 mm.

Breathing horns reddish brown; thoracic dorsum reddish brown, with an interrupted itish line running down posterior half of mesonotum; sheaths of wings and legs pale

brown; abdomen whitish yellow, posterior half of each sternite and tergite dark brown; basal half with two narrow transverse lines of same color.

Lobes of cephalic crest widely separated, subtriangular, acutely pointed at tips. Pronotal breathing horns cylindrical, transversely wrinkled, tapering gradually to tips. (In the only specimen at hand, the horns are widely separated at the base but soon bend proximad and thence outward and ventrad, so that the two horns are closely approximated or almost contiguous on their distal parts.) Behind breathing horns, mesonotum with conspicuous divergent lobes such as are described for *E. chlorophylla*; mesonotum at crest with abundant black setiferous tubercles, which are fewer in number, smaller, and more scattered along shoulder, interrupted at mid-dorsal line. Hind legs a little longer than fore legs, which in turn, are a little longer than middle legs.

Abdominal segments with subterminal armature of posterior ring more spinous than in *E. chlorophylla*. Distribution of setae about as in *E. chlorophylla*.

(Described from a pupa taken at Orono, Maine, June 24, 1913.)

Erioptera septemtrionis O. S.

1859 *Erioptera septemtrionis* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

Erioptera septemtrionis is a widely distributed species thruout the northeastern United States and Canada. The larvae are not uncommon in rich organic mud in cool, shaded woods. The writer found them commonly in the Standpipe Woods, Orono, Maine, in July and August 1913. A larva placed in rearing on July 3 transformed to an adult female on the 16th. Other larvae placed in rearing on July 15 transformed to adult males on the 25th. This limits the pupal duration to not more than ten days, but it is probably much less, presumably about one week.

Pupa.— Length of cast skin, 7 mm.

Cephalic crest low and flat. Antennal sheaths moderately elongated, individual segments showing clearly thru sheaths. Pronotal breathing horns elongate, cylindrical, almost straight but slightly diverging, transversely wrinkled, paler at tips, with a row of small breathing pores along apical margin; a few small setiferous tubercles before base of breathing horns. Declivity of mesonotum rather steep, at crest with numerous small tubercles and abundant pale yellow hairs which are less numerous along shoulder. Leg sheaths with middle pair conspicuously the shortest, as in the genus.

Abdominal segments with subterminal armature of posterior ring consisting of stout pale setae; arrangement of these setae about as in *E. chlorophylla*. Lateral spiracles distinct. Male cauda (Plate LXIX, 371 and 372) with the ventral lobes blunt at tips, obliquely truncated, separated by an acute V-shaped notch; dorsal lobes separated by a U-shaped notch, each lobe terminating in a small tip, with two tiny setae on lateral face before apex; dorsum of eighth segment with four prominent, pale, fleshy lobes which are closely approximated, the anterior pair directed laterad and a little more distant from each other than the posterior pair, which are directed more dorsad.

Neanotype.— Orono, Maine, July 25, 1913. No. 105–1913.

ıbgenus **Hoplolabis** Osten Sacken)

1869 *Hoplolabis* O. S. Mon. Dipt. N. Amer., part 4, p. 160.

The subgenus Hoplolabis includes but three known species — the type the group, *Erioptera* (*Hoplolabis*) *armata*, discussed below; *E.* (*H.*) *artita* O. S., of western North America; and *E.* (*H.*) *asiatica* Alex., Japan.

ioptera (*Hoplolabis*) *armata* O. S.

1859 *Erioptera armata* O. S. Proc. Acad. Nat. Sci. Phila., p. 227.

Erioptera armata is a rather common fly thruout the northeastern ited States. A larva was found in the sand along the banks of Fall eek, Ithaca, New York, on May 16, 1917. This larva was of the ıical eriopterine form, being elongate, terete, and with the spiracular k surrounded by five subequal lobes. It was placed in rearing and nsformed to an adult female on May 31. This larva was found associ-ed with numerous hexatomine larvae, such as *Eriocera spinosa*, *E. gicornis*, and *E. cinerea*.

The following description is from the cast pupal skin.

Length, about 7 mm.

Cephalic crest consisting of two moderately large, slightly divergent lobes which are tely pointed at tips; lobes directed strongly outward and bearing a seta on outer face. ɔrum acutely pointed. Labial lobes large, divergent, almost straight across caudal margin. eaths of maxillary palpi stout, rather pointed at tips. Pronotal breathing horns broad base, tapering to slender apices, bases conspicuously wrinkled; a small setiferous ercle before base of each breathing horn. Mesonotum at crest (Plate LXIX, 373) ɔ numerous short, chitinized points. Lateral angle of thorax with two setae; a strong above wing axil. Leg sheaths with middle tarsi ending conspicuously before tarsi of er legs.

Each abdominal segment before posterior margin with a transverse row of slender black cules or short bristles on tergum and sternum, and smaller areas on pleura. Lateral ominal spiracles distinct. Setae on pleura just ventrad of spiracle, and on tergum just ve transverse row of spicules. Female cauda with tergal valves elongated, gently urved, unarmed; sternal valves shorter, blunt; at base of cauda, on dorsum of eighth seg-nt, four small darkened tubercles which are produced into slender tips.

Neanotype.— Cast pupal skin, Ithaca, New York, May 31, 1917.

ıbgenus **Mesocyphona** Osten Sacken)

1869 *Mesocyphona* O. S. Mon. Dipt. N. Amer., part 4, p. 161.

Mesocyphona is one of the larger subgenera of Erioptera, reaching its ximum of specific development in the Tropics of the New World.

The immature stages of *Erioptera* (*Mesocyphona*) *caloptera* (Say) an *E.* (*M.*) *parva* O. S. are spent in wet mud along the banks of stream and other bodies of water. The species discussed below as *Eriopter* (*Mesocyphona*) species (near *knabi*), was reared from the sandy margin of a small prairie stream in Kansas.

Erioptera (*Mesocyphona*) species (near *knabi* Alex.)

Adult flies of a small species of Mesocyphona which is close to *E.* (*M knabi* Alex., of Mexico, were not uncommon along Buckner Creek, a smal prairie stream flowing thru Jetmore, Kansas. These adults, especiall the females, were photophilous, appearing in considerable numbers aroun lanterns which were hung in tents pitched along the banks of this strea A single pupa found in the muddy sand along the bank of the creek o July 20, 1917, emerged as an adult on the 22d. The following genera characters of the species may be noted:

Pupa.— Labrum small, apex rather sharp. Labial lobes squarely truncated, with later angles subacute. Sheaths of maxillary palpi slender. Pronotal breathing horns moderatel long, cylindrical, curved slightly forward, enlarged outwardly, blunt at tips. Mesonotu at crest rather tumid and with a few long hairs inserted on stout black tubercles. Leg sheati with middle tarsi the shortest, hind tarsi the longest.

Neanotype.— Jetmore, Hodgeman County, Kansas, July 22, 1917.

Genus **Ormosia** Rondani (Gr. *chain*)

1856 *Ormosia* Rond. Dipt. Ital. Prodr., vol. 1, p. 180.
1860 *Rhypholophus* Kol. Wien. Ent. Monatschr., vol. 4, p. 393.
1863 *Dasyptera* Schin. Wien. Ent. Monatschr., vol. 7, p. 221.

Larva.— Form terete, moderately elongated. Spiracular disk squarely truncated, su rounded by five subequal lobes which are lined with double marks of brown. Anal gil blunt. Head capsule slender, very dissected, of six narrow bars, four dorsal and two ventra the ventral bars broader. Labrum narrow, epipharynx hairy. Mandible with teet moderately elongated. Antenna of the Molophilus type. Mentum without chitinize teeth.

Pupa.— Cephalic crest setiferous. Pronotal breathing horns rather short and stou more or less flattened and with a row of tubercles along posterior margin. Mesonotu declivitous, at crest with a flattened, toothed, chitinized plate on either side (in *O. nubil* or with abundant setiferous tubercles. Wing sheaths ending opposite or just beyond t of second abdominal segment. Leg sheaths varying in length with the different specie middle tarsi the shortest. Abdominal segments with a subterminal transverse row of spin or setae, these occurring on pleura (as small groups of eight to twelve) as well as on tergit and sternites. Lateral spiracles distinct, on segments 2 to 7; dorsum of segment 8 wi

agon of five lobes, these being unarmed (*O. innocens*, *O. meigenii*) or spinous-tipped *bila*, *O. nigripila*).

mosia is a large and rather difficult genus (including more than nty-five species) of small crane-flies which are characteristic of sub- and temperate regions and apparently rare or lacking in the Tropics. e adult flies occur in small dancing swarms, usually in cool, shaded tions in or near woods or along brooks. They are most numerous rly spring and in late summer or early autumn, many of the species apparently double-brooded.

e immature stages are spent in moist organic mud near water. In pe, Beling records *Ormosia haemorrhoidalis* (Zett.) (Beling, 1879: 9, and 1886:191–192), *O. lineata* (Meig.) (Beling, 1886:202), and *dulosa* (Macq.) (Beling, 1886:202), as being found in wet earth in s, usually beneath leaf mold. Cameron (1917:65) likewise records the named species as living in mud. *O. varia* (Meig.) was found by De ere (1916:201–204) among decaying leaves in a wet spot near a ditch. the American species, the writer has bred *Ormosia innocens*, *O. a*, *O. meigenii*, and *O. nigripila* from larvae or pupae in entirely ar situations to those given above for the European species.

e larvae of only two of these species, *O. nubila* and *O. meigenii*, are able to the writer at this time. *O. nubila* is a large brown species; *eigenii* is much slenderer, and is light yellow in color.

e pupae of the known Nearctic species may be distinguished as vs:

sum of eighth abdominal segment with a pentagon of five lobes which are spinous t their tips 2
sum of eighth abdominal segment with a pentagon of five fleshy lobes. 3
st of mesonotum with a flattened chitinized plate on either side of median line.
O. nubila (O. S.) (p. 923)
st of mesonotum tumid, with abundant coarse, yellowish setae on either side of median ne . . . . . *O. nigripila* (O. S.) (p. 927)
lomen with large, rectangular, dusky areas on posterior annuli of segments 2 to 8, iving abdomen a banded appearance; pleural setae rather numerous.
O. innocens (O. S.) (p. 925)
lomen without such dusky areas; pleural setae few in number.
O. meigenii (O. S.) (p. 928)

sia nubila (O. S.)

59 *Erioptera nubila* O. S. Proc. Acad. Nat. Sci. Phila., p. 227.

nosia nubila is probably double-brooded, since the flies are on the in the spring and again in the fall. The immature stages live in

organic mud that is usually covered over with a layer of leaf mold. (
March 27, 1914, the writer found four large brown eriopterine larvae
rich earth from Needham's Glen, Ithaca, New York. An adult fem
of the present species emerged on April 9. This makes the maxim
pupal existence less than two weeks, but it is undoubtedly very mu
less than this.

Larva.— Length, 11.5–11.8 mm.
Diameter, 1.1–1.2 mm.

Color a deep reddish or cinnamon brown; incisures of segments paler.

Form rather stout, body terete. Skin covered with a short, appressed pubesce
Spiracular disk (Plate LXX, 375) squarely truncated, surrounded by five subequal l
ventral lobes with two parallel dark brown lines which are narrowly united distally, the
stripe between rather broad, distinct, especially near center of disk; lateral lobes with
parallel dark brown stripes which are indistinctly connected distally, the space betw
dusky with numerous brown spots; dorsal lobe with an elongate-oval mark inclosing a lin
yellow center; lobes fringed with long hairs which are longest at tips, shorter toward b
and narrowly interrupted between lobes; disk between spiracles unmarked. Spiracles la
middle piece and extreme outer margins of ring blackish; spiracles separated by a dista
about equal to one and one-half times diameter of one.

Head capsule about as in Molophilus, but ventral bars of capsule not toothed to f
the characteristic mental plate of that genus. Labrum and epipharynx about as in M
philus. Hypopharynx broad, flattened, provided with numerous transverse rows of sh
setae. Antenna short; basal segment stout, cylindrical; apical papilla rather sm
elongate-oval. Mandible (Plate LXX, 374) ending in a rather long apical point, with ab
four long, flattened teeth along ventral cutting edge, the second from base very small; a sh
recurved hook at prosthecal region and a dense tuft of long yellow hairs in prosthecal sli
dorsal appendage at heel of mandible. Maxilla about as in Molophilus.

Pupa.— Length, 7.5 mm.
Width, d.-s., 1.2 mm.
Depth, d.-v., 1.4 mm.

Head, thorax, and appendages pale yellow; breathing horns yellow; chitinized plates
mesonotum dark brown; abdomen brown. (In mature pupae, the sheaths of the appenda
are probably darker.)

Cephalic crest (Plate LXXI, 381) low; lateral angles produced into conical, er
spinous tubercles, each bearing a stout seta on outer ventral face. Antennal sheaths v
angulated, almost serrate. Opposite each segment of antenna on basal half of organ
conspicuous blackened tubercle, those at base larger and more conspicuous, the lateral
directed outward, above it a second tubercle directed cephalad and simulating a cr
Antenna extending to just beyond base of wings. Front broad; a blackish area on eit
side near inner margin of eye, probably indicating point of attachment of tentorium. Labr
triangular, apex subacute. Labial lobes triangular, tips blunt. Sheaths of maxillary p
rather long, narrowed to the slender tip. Pronotal breathing horns short and slender, so

flattened, pale yellow; a stout seta just before base of each breathing horn. Mesonotum pitous; at crest (Plate LXXI, 380) on either side of median line, a heavily chitinized ned plate projecting dorsad; this plate, at its tip, forking into two lesser teeth, the ıl one of these still further subdivided into two still smaller teeth (in one specimen ft plate is divided dichotomously into four teeth, the inner primary tooth being further vided); on shoulder laterad of these plates a slightly swollen plate which is parallelly ed; two spines on lateral angle of thorax above base of wing; mesonotum with a few behind crest, as follows: an anterior solitary seta on either side of median line and close a solitary stout seta above wing axil, two groups of paired setae, one just dorsad of base ıg and the other midway between this group and the anterior seta first described. Wing hs rather short, ending opposite base of third abdominal segment. Leg sheaths rather for this genus, ending opposite midlength of fifth abdominal segment; fore tarsi a little er than hind tarsi, middle tarsi very short, ending opposite or just beyond end of third segment of fore legs.

dominal segments near posterior margin with transverse rows of short black spineg are much smaller and more widely separated near ends of row; at intervals alona few elongate setae; on pleura a similar area of eight to eleven spines with a single sets ; tubular lateral spiracles on segments 2 to 7. Chaetotaxy as follows: on pleura, just dorsal end of row, one seta, another solitary seta cephalad of spiracle on anterior on tergites, a solitary seta on posterior ring about opposite spiracle; on sternites, two setae on either side of median line of posterior ring. Female cauda (Plate LXXI, 382) tergal valves long and slender, almost straight but slightly upcurved near tips; on lateral margin, just before tip, a prominent tooth directed laterad and slightly caudad; midlength of valves a somewhat similar blunt tubercle on either side near dorsal margin; se of eighth tergite a pentagon of five chitinized lobes, the anterior one rudimentary, our developed lobes ending in acute chitinized points and each bearing a subapical anterior pair of lobes more widely separated and bearing on lower side near base a slender lobule.

pionotype.— Ithaca, New York, March 27, 1914.
anotype.— Ithaca, with type larva, April 9, 1914. No. 2–1914.
ratypes.— With types.

psia innocens (O. S.)

869 *Rhypholophus innocens* O. S. Mon. Dipt. N. Amer., part 4, p. 142.

mosia innocens is a characteristic early spring species, the adult being found in late April and during May. On May 12, 1917, a pupae in an advanced stage of development were sifted from organic from Bool's hillside, Ithaca, New York. One of these emerged as dult on the following day. The associated crane-fly larvae that rred with this species on the date named were as follows: *Bittacohella jonesi, Dicranomyia stulta, Limnophila adusta, L. fuscovaria, norpha pilosella, Penthoptera albitarsis, Rhaphidolabina flaveola,*

Molophilus hirtipennis, Erioptera megophthalma, Ormosia nigripila, Tipu oropezoides, T. collaris, T. cayuga.

Pupa.— Length, 7.5–10.5 mm.
Width, d.-s., 0.8–1 mm.
Depth, d.-v., 1–1.2 mm.

(The smaller measurements are those of males, the larger those of females.)

Head and thorax brown; mesonotum before declivity darker brown; abdomen pale yellow white, the sternal and tergal sclerites with broad, rectangular, darker areas, producing banded appearance; breathing horns pale yellow. (In older pupae, the coloration of head and the thorax is much darker.)

Cephalic crest of moderate size, bilobed; viewed from side, lobes blunt, with two late setae; viewed from front, lobes separated by a very broad, V-shaped notch. Between anten bases, forehead longitudinally grooved, these lines converging between eyes. Labr triangular, subacute, separating the small labial lobes. Maxillary palpi of moderate leng tapering to blunt apices. Antenna of moderate length, reaching to just beyond wing ba Pronotal breathing horns rather short and stout, almost straight and only slightly dive ing, subcylindrical, compressed, and slightly constricted just beyond base. Me notum precipitous, carinate medially; at crest (Plate LXX, 376) with numerous p hairs, these narrowly interrupted on median line; lateral angle of thorax with two tiny set a strong seta slightly dorsad and cephalad of wing root; about four small setae in alinem across mesonotum. Wing sheaths moderately broad, ending at or just before tip of seco abdominal segment. Leg sheaths short, tips of all the tarsi ending about on a level, those of fore legs a little longer, terminating just before end of third abdominal segme

Abdominal segments divided into two distinct annuli by a constriction at about m length of segment; sternum and tergum of posterior ring of segments 2 to 8 near cau margin with large, rectangular, dusky areas which appear subchitinized; caudal margin this area with a fringe of long, black hairs, there being about seventy-five of these on int mediate segments; on pleural membrane a very small, similar area bearing from twenty-f to thirty-nine hairs, and near its dorsal margin a distinct black tubular spiracle on segme 2 to 7; the following additional setae on segments: on dorsal segments, rectangular darker areas with sparse scattered elongate hairs over surface, and two setae on each anterior vent angle, their arrangement oblique; sternal segments similar, but the two setae on rectangu area arranged transversely; just caudad of ends of fringe of hairs, one or two isolated hai pleural membrane opposite basal annulus with a single seta; another seta opposite poster annulus near ventral margin; a third seta on ventro-cephalic angle of pleural setifer area just above level of spiracle; segment 8 on dorsum with five pale, gill-like lobes arrang in a quadrangle or a pentagon, the anterior lateral pair the longest, the median one rather smallest; at base of anterior pair, two setae on cephalic face; at base of posterior pair single seta on lateral face. Male cauda (Plate LXX, 377 and 378) terminating in two v blunt ventral lobes and two separated, slender, dorsal lobes projecting caudad and dors Female cauda similar to male cauda, but tergal acidothecae very elongate, much longer th sternal valves.

Neanotype.— Ithaca, New York, May 12, 1917.
Paratypes.— Seven pupae, with type.

mosia nigripila (O. S.)

1869 *Rhypholophus nigripilus* O. S. Mon. Dipt. N. Amer., part 4, p. 142.

The larvae of *Ormosia nigripila* are common in rich organic mud in ady places. Larvae found in Needham's Glen, Ithaca, New York, March 27, 1914, emerged on April 18. Other larvae from Coy Glen, ind on April 17, emerged on May 1. At Orono, Maine, large larvae re found on July 14, 1913, and were placed in rearing, emerging on e 26th as adult males. This limits the pupal duration to not more than o weeks, but it is undoubtedly much less, probably not more than a v days or a week.

Pupa.— Length, 5.2 mm.
Width, d.-s., 0.9 mm.
Depth, d.-v., 1 mm.

Head, thorax, and appendages light brown, becoming darker in maturity; breathing horns l abdomen pale whitish.

Cephalic crest with lobes small, low, and rounded, with a powerful seta at tip, directed ward. Labrum blunt at apex. Labial lobes large, subtriangular, lateral angles obtusely nted. Sheaths of maxil'ary palpi stout, rather elongate. Pronotal breathing horns ate LXXII, 384) rather short and flat, compressed, slightly expanded beyond base; outer, posterior, margin with about five small tubercles, at least one of which is setiferous. sonotum very steep and precipitous, as in this group of species; crest (Plate LXXII, 383) nid, extensive, on either side with abundant coarse yellow bristles; caudad of these, four ut setae in a quadrangle, two on either side of median line; lateral angles of thorax with stout setae; a strong seta just above wing base. Wing sheaths reaching base of third ominal segment. Leg sheaths moderately long, extending almost to midlength of fourth ominal segment; tarsi of middle legs much shorter than the others, hind legs a very little ger than fore legs.

bdomen with segments (Plate LXXII, 385) before their caudal margin bearing transverse s of slender spines; pleura with a small area lying a little cephalad of tergal and sternal s and margined behind with eight to ten spines. Spiracles distinct, tubular. Setae ollows: on pleura, a seta on anterior annulus, a stout seta just ventrad of spiracles, and nird lying a little ventrad and cephalad of spiracle; on sternites, two stout setae near e of posterior annulus; on tergites, two setae on posterior annulus, lying transversely evel of spiracle, and a third seta just cephalad of end of row of spines. Male cauda (Plate XII, 386) with ventral lobes rather slender, narrowed outwardly, and somewhat pointed apex; dorsal lobes curved strongly backward, terminating in acute, chitinized points n a strong seta on outer face before tip and a second seta nearer base; dorsum of segment 8 n five brown, chitinized lobes which are crowned at their apices with a circlet of spines; erior pair the longest and stoutest, broad at base, more slender outwardly, with a large ral spine and about three smaller inner sp nes; anterior pair more slender; median lobe der, crowned with a circlet of about six small, subequal spines. Female cauda (Plate

LXXII, 387) with dorsal terebra elongate, almost straight or very slightly upturned; eighth segment with dorsal pentagon of spine-tipped lobes quite as in male.

Ormosia meigenii (O. S.)

1859 *Erioptera meigenii* O. S. Proc. Acad. Nat. Sci. Phila., p. 226.

Ormosia meigenii is one of the commonest species of the genus, occurring in small dancing swarms in early spring. Larvae of this species were taken on April 10, 1914, in organic mud from Needham's Glen, Ithaca, New York. An adult female emerged on May 4.

Larva.— Length, 6.5 mm.
Diameter, 0.5–0.6 mm.

Color, light yellow.

Form elongate, terete. Spiracular disk (Plate LXX, 379) about as in *O. nubila*, dorso-median lobe the smallest, ventral lobes with brown lines rather close together, the distal line the broadest; lateral lobes with lines rather short, not contiguous at their distal ends and not extending past midlength of spiracles; dorso-median lobe with marks oval, solidly dark brown. Lobes fringed with moderately long, yellowish setae, which are almost lacking at extreme tips; disk between spiracles unmarked. Spiracles large, transversely oval, separated by a distance a little greater than the long diameter of one.

Head capsule and mouth parts almost as in *O. nubila;* mandible with the long, slender teeth of that species.

Pupa.— (Described from a cast skin.)

Cephalic crest consisting of low, rounded lobes, each with a seta on anterior lateral face. Pronotal breathing horns of moderate length, flattened, a little narrowed toward tip, outer margin with fine tubercles. Mesonotum not so declivitous as usual in the genus, with tiny roughenings at crest; the usual two setae at lateral angle of thorax present, another above each wing, and four more in a transverse row at level of axilla of wing; a seta on mesonotum close to median line, just below crest. Middle legs much shorter than fore and hind legs.

Subterminal rows of setae on abdominal segments consisting of slender, acute spines, with a few setae interspersed; on pleura the spines few in number. Spiracles elongate, tubular. Female cauda with tergal sheaths very long, sternal sheaths short, their tips blunt; on dorsum of eighth abdominal segment five small unarmed tubercles, which are blunt or nearly so, anterior pair more widely separated than posterior pair. (In the shape of the cephalic crest, the breathing horns, and the declivity of the mesonotum, this species resembles *O. nigripila*; but the arrangement of setae on the abdomen, and the great reduction and unarmed condition of the lobes on the eighth abdominal tergite, are distinctive.)

Nepionotype.— Ithaca, New York, April 10, 1914.
Neanotype.— Cast pupal skin, Ithaca, May 4, 1914.

Genus **Helobia** St. Farg. et Serv. (Gr. *marsh + I live*)

1825 *Helobia* St. Farg. et Serv. Encyclop. Method. Ins., vol. 10, p. 585.
1830 *Symplecta* Meig. Syst. Beschr., vol. 6, p. 282.
1865 *Idioneura* Phil. Verh. Zool.-Bot. Ges. Wien, vol. 15, p. 615.
1886 *Symplectomorpha* Mik. Wien. Ent. Zeitung, vol. 5, p. 318.

a.— Form moderately elongated, body terete. Spiracular disk surrounded by five ıal lobes which are marked with V-shaped brown lines, in some specimens the inner of the three most dorsal lobes being entirely brownish black. Anal gills moderately te. Head capsule as in the Eriopterini. Antenna with the apical papilla very short, iform.

a.— Cephalic crest setiferous. Pronotal breathing horns elongate-cylindrical, directed d and cephalad, with rows of breathing pores along dorsal face. Mesonotum tous, at broad crest armed with numerous chitinized spines; an arcuated longitudinal six small pits extending from wing axil toward crest of thorax. Wing sheaths ending tip of second abdominal segment. Leg sheaths ending about opposite tip of third inal segment; tarsi of hind legs the longest, those of middle legs the shortest, fore termediate in length. Abdominal segments with a strong subterminal armature on l segments, much weaker to lacking on dorsal segments; lateral spiracles distinct on ıts 2 to 7; dorsum of segment 8 with five blunt lobes.

lobia is a small genus (five species) of common and sometimes very y distributed crane-flies. The only North American species, *Helobia da*, is apparently the most widespread tipulid known, ranging over ically the entire Holarctic region, southward in the mountains to , and, in the New World, to Central America. The immature s of the known species are spent in moist earth near water. Bruch tt.) mentions the rearing of *H. macroptera* (Phil.) in Argentina.

ia hybrida (Meig.)

04 *Limonia hybrida* Meig. Klass., vol. 1, p. 57.
18 *Limnobia punctipennis* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 147.
30 *Symplecta punctipennis* Meig. Syst. Beschr. Zweifl. Ins., vol. 6, p. 283.
48 *Limnobia cana* Walk. List Dipt. Brit. Mus., vol. 1, p. 48.

obia hybrida is undoubtedly the most widely distributed North ican crane-fly. Beling (1879:50–51) found larvae and pupae at nd of July, 1876, in wet, sandy earth along the margins of small s in deciduous woods. Adults emerged in his breeding cages on 27 and August 6. Hart (1898 [1895]:199–200) found the larvae in r sandy situations along the Illinois River, associated with the e of *Tabanus atratus* Fabr. He suggests that it may serve as food is horse-fly larva. Larvae of Helobia were especially abundant on 17, and these transformed to adults within a month. Females observed ovipositing along the shore, patting the valves of the sitor against the moist sand. Malloch (1915–17b:229–230) has additional notes on the structural details of Hart's material.

Dr. Adam Böving found this species in Iceland and made careful no on the burrows made by the larvae. Thru the kindness of Dr. Bövi the writer is able to include a translation of his manuscript. The wri is indebted also to Dr. Lundbeck, director of the museum at Copenhag for the loan of this material for study. These are the specimens discus later in this paper. Böving's notes were made at Fell Station, southe Iceland, in 1908. The translation follows:

Inside the moraine of 1877, in the low land where ice was standing in 1886, quantiti dipterous larvae were found in the moist sand on the bottom of flat hollows which at t are flooded by water and at times are partly drained, as was the case on the day whe following observations were taken.

The whole dark, moist surface of the bottom was covered by an irregular system of sli elevated, long, tubular galleries, some of which were rather straight, some formed br lines, some peculiar arabesques, and some plain spirals. The width of the galleries was al the size of an ordinary pinhead, some a trifle larger, some a little smaller. In the ant part of each gallery was found either a cylindrical white tipulid larva (Helobia) about centimeter long, or another dipterous larva of the same general size and appearance. larvae were found just below the surface. It was not always easy to capture them, for w I pushed my knife under the mouth of the gallery they moved quickly backward, and t digging deeper into the soil, made a new gallery that branched off from the main one. was not possible to distinguish the galleries of the crane-fly larvae from those of the o dipterous associate. Very often, from the mouth of the spiral galleries, one-third broken pupal skin stuck out; but larvae were found also in many of these galleries.

The imagines of the two Diptera were present in large numbers, some flying close to ground, others resting on it. Both forms were long-legged and capable of running the water film. I secured a pair of both in copulation. The eggs were found on the m surface, singly or in small masses of two or three together.

The larvae feed, of course, on organic particles in the sand. The imagines were not obser to take any nourishment at all; they copulated as soon as they had left the pupal skins, I did not find them in any other place than on the bare, moist soil where the larvae li not, for instance, on flowers growing near by.

A small carabid (probably *Bembidion grapii* Gyll.) was present in the locality in c paratively large numbers, evidently preying on the larvae of the Diptera. A single c bid larva also was found; from its size and habitus it may very well be the larva of Bembidion.

A small black spider was probably feeding on the imagines of the Diptera. It did not m a regular web, but spun a number of single threads, each about two feet long, attaching t to a piece of gravel and proceeding from this as a common center, spreading the thr close to the ground like radii, and finally fastening the ends to small grains of sand.

The adult flies of *Helobia hybrida* are very common. They are first tipulids to appear on the wing in spring, some appearing in ea March or, in open winters, even in late February. They remain u late in the fall. The writer has noted the females running about on wet sand along the banks of the Kaw River at Lawrence, Kansas, a ovipositing quite as described by Hart (1898 [1895]: 199–200).

Larva.— Length, 7.8–10 mm.
Diameter, 0.6–0.7 mm.

Coloration, pale brownish yellow.

Form moderately elongated. Body covered with a sparse appressed pubescence. Spiular disk (Plate LXXIII, 388) surrounded by five lobes, the dorsal one notably smaller n the paired lobes; inner face of lobes with two subparallel brown lines, connected at ir outer ends to form narrow V's; disk marked with about six spots between spiracles, largest at base of ventral lobes; disk fringed with short hairs, which are interrupted for hort distance between lobes. Anal gills moderately elongated, pale. (Beling describes three dorsal lobes of the disk as having the entire inner face shiny blackish brown, and ventral lobes merely margined with brownish; there would thus seem to be some varia- n in the character and degree of markings in this species.)

Head capsule as in the tribe. Antenna with the basal segment stout, cylindrical, the cal papilla very short, subpyriform. Mandible flattened; teeth large but very bluntly nded; apical tooth the largest, with a slightly smaller denticle on either side.

Pupa.— Length, 7–9 mm.

Cephalic crest small; lobes pointed, directed ventrad, each bearing a short, stout seta. orum narrow. Labial lobes large, divergent, caudal margin almost straight across. Sheaths maxillary palpi slender, narrowed at tip (Plate LXXIII, 390). Antenna moderately ulated, ending just beyond base of wing. Pronotal breathing horns elongate-cylindrical, ected ventrad and cephalad, with rows of breathing pores along dorsal face; ventral face nsversely wrinkled. Mesonotum moderately declivitous, at broad crest (Plate LXXIII,) armed with numerous black chitinized spines directed backward; these spines most n rous proximally, interrupted by a median space, less numerous along shoulder; four setae a transverse row across mesonotum, two on either side of median line; lateral angle of rax broad and blunt, with two small setae, the outermost one the larger, the inner one ut half its size; an arcuated longitudinal row of about six pits extending from above of wing toward crest of mesonotum. Wing sheaths short, ending before tip of second ominal segment. Leg sheaths ending opposite or slightly beyond tip of third abdominal ment; hind legs much the longest, middle legs much the shortest, fore legs intermediate ate LXXIII, 391).

bdomen with a rather strong armature of stout black spines on sternal segments, on ment 3 this appearing as a small area of about ten spines, on either side of tips of hind si; tergal armature much weaker or lacking; lateral spiracles very distinct, tubular, in t pupal skin the principal tracheal trunks being very conspicuous. Female cauda (Plate XIII, 393) with tergal valves the longest, terminating in sharp cylindrical points; sternal ves much shorter, blunt at tips; dorsum of segment 8 with five blunt lobes. Male cauda ate LXXIII, 392 and 394) with dorsal valves the longest, each terminating in a long, acute, chitinized spine directed dorsad and laterad and bearing before its tip two stout ae; ventral lobes stout and blunt, longer than dorsal lobes.

Nepionotype.— Fell, between Öraefa and Heineberg, southeastern Iceland.
Neanotype.— Cast pupal skin, with type.
Paratypes.— Numerous cast pupal skins, with types (in the collection of the Copenhagen seum).

Genus **Trimicra** Osten Sacken (Gr. *three* + *small*)

1861 *Trimicra* O. S. Proc. Acad. Nat. Sci. Phila., p. 290.

Trimicra is a small genus of crane-flies, including about fifteen describe species found in most parts of the world, almost all being forms of moderat size and obscure coloration. These various species bear a close resem blance to one another and are hard to distinguish specifically.

Bergroth and other European writers consider the genus Trimicra a being the same as Psiloconopa Zetterstedt, but at this time the write is not entirely willing to accept this view.

Beling (1879:48) described what he took to be the larva of one o these flies, and in his key to the larvae of crane-flies (1886:206) h included it in close proximity to the Pediciini. As mentioned elsewher in this paper, it is highly probable that Beling described a pediciine larva but by an accident had larvae of Trimicra in his breeding jars, the latte larvae emerging first and confusing the author.

Gerbig (1913:161–163) describes the real larva of *Trimicra pilipe* (Fabr.), the best-known species of the genus. It is found along th margins of flowing streams with muddy banks. It is a dark-colored larva, about 15 millimeters in length and about 2 millimeters i diameter. The skin of the body is similar to that of the larvae in th typical subgenus of the genus Limnophila, being covered with chitinous hairlike projections, which in Trimicra are longest on the dorsal surface o the body. On each segment there are solitary elongate bristles, above an below each of which is a gland. The spiracular disk (Plate LXXIII, 395 is surrounded by five nearly equal lobes, which have the inner face marked with equal blackened, chitinized areas. On the lateral margin of each lobe, but occupying only the distal part of the lobe and not con tinuous around the disk, is a fringe of moderately long hairs. At th tip of each ventral lobe are two bristles, and at the tip of each latera lobe is a single bristle, these being inserted outside the line of hairs an surrounded by a bright circular area. The ventral sensory bristles foun in some crane-fly larvae (as *Tipula variipennis*) are lacking. At th base of the lateral lobes are the spiracles, which are generally similar t those in the subgenus Limnophila. Gerbig discusses in detail the structur of the spiracles, the felt chamber, and the musculation of this regio of the body.

Bruch (*in litt.*) mentions the rearing of *Trimicra reciprocа* (Walk.) in entina from larvae very similar to that described above, occurring in same type of habitat.

us **Empedomorpha** Alexander (Gr. *Empeda* + *shape*)

1916 *Empedomorpha* Alex. Proc. Acad. Nat. Sci. Phila., p. 507–508.

Empedomorpha is a monotypic genus of flies, evidently related to micra. It is very curious in its marked sexual dimorphism, the male ing an extremely large, hairy stigma, which encroaches upon the oining veins and often distorts them. The fly is still very insufficiently wn. It is a prairie-inhabiting species, occurring from South Dakota Texas and New Mexico. Nothing is known concerning the immature es, and the following observations on the habits and occurrence of adult flies are all that are available.

pedomorpha empedoides (Alex.)

1916 (?) *Trimicra empedoides* Alex. Can. Ent., vol. 48, p. 44–45.

Empedomorpha empedoides, as stated under the generic account above, prairie-inhabiting species. Adult flies were found running about the sand flats of the Arkansas River, near Cimarron, Kansas, from 13 to 15, 1917, by H. L. Fackler and the writer. The vegetation ne sand bars here is very sparse to almost lacking, a few psammophytic ses being the main element. Associated with these flies on the sandy ace were a characteristic group of sand-loving insects, of which the owing were the most constant: larvae and adults of tiger beetles, esenting at least three species of Cicindela; ground beetles, Carabidae, uding such genera as Omophron, Dyschirius, Bembidion, Tachys, and w others; rove beetles, Staphylinidae, such as Stenus; Heteroceridae, mmocharidae, Asilidae, Saldidae, and similar groups. In the cool of y evening, numerous small spiders that lurk in hollows and in deserted ct burrows during the day emerge from hiding and become active.

he crane-flies were observed during the hours of bright sunlight, when temperature registered over 100° F. in the sun. They run rapidly the moist sand, their course being very shifting and zigzag, quite that of tiger beetles. They fly readily but only for short distances, prefer to alight on the sand rather than on the vegetation. They awkwardly over the sand, but are able to crawl up grass blades or

similar objects. The habits of the adult flies are strikingly like thos of Helobia (page 930). The writer is sure that the larvae are to be foun in the sand in these same haunts.

Genus **Gnophomyia** Osten Sacken (Gr. *darkness* + *fly*)

1859 *Gnophomyia* O. S. Proc. Acad. Nat. Sci. Phila., p. 223.
1867 *Furina* Jaenn. Abhandl. Senkenb. Ges., vol. 6, p. 318.
1911 *Dasymallomyia* Brun. Rec. Indian Mus., vol. 6, p. 304.

Larva.— Body slender, tapering toward ends, with transverse welts on intermediat abdominal segments. Spiracular disk surrounded by five subequal lobes. Anal gills con sisting of four blunt, rounded lobes, constructed for propulsion rather than for a respirator function. Head capsule moderately elongated, rather compact for the Eriopterini. Antenn rather small, apical papilla elongate-oval. Mandible slender, with a long apical point an three teeth along ventral cutting edge.

Pupa.— Cephalic crest a low, blunt tubercle on either side of median line, each tippe with a long seta. Pronotal breathing horns small, narrowly trumpet-shaped. Mesonotur moderately declivitous, at crest practically unarmed; a strong seta at lateral angle of thora and another on either side of mesonotum behind crest. Wing sheaths short, ending befor tip of second abdominal segment. Leg sheaths very short, reaching just beyond wing attaining end of second abdominal segment; all the tarsi ending about on a level. Abdom provided with long setae; spiracles on abdominal segments 2 to 7.

Gnophomyia is a small genus including about forty described speci which are most abundant in the Tropics of the New World. The Europea *Gnophomyia tripudians* Bergr. has recently been reared by Gamkrelidz (1913, a and b) and by Keilin (Edwards, 1919b). The former foun larvae in large numbers in the viscous, semi-decomposed mass of tissu beneath the bark of a fallen carolina poplar, associated with *Miasto metraloas* Meinert. These larvae were found near Paris, France, i March, 1911. Gamkrelidze records a gregarine parasite in the intestin and a nematode worm in the body cavity. The species was later reare in England from dead oak by Keilin, who has discussed and figure glands in the larvae (1913:3). The only American species that has bee reared is the common *Gnophomyia tristissima*, discussed later.

Gnophomyia rufa Hudson, of New Zealand, has recently been discusse in some detail by Hudson (1920:32–33). It is occasionally found in dens forests in the vicinity of Wellington. The larva lives in and feeds on th semi-liquid vegetable detritus which accumulates in large quantities a the bases of the leaves of *Astelia Solandri*, a common and very conspicuou epiphytic plant in most of the primitive native forests. The length o

fully grown larva is slightly over 30 millimeters. It is subcylindrical, iderably flattened. Oval warts armed with minute teeth are situated oth surfaces of abdominal segments 2 to 7. The larva is very dark gray in color, darker toward the extremities. The spiracular disk hown by Hudson's colored figure is very small. Apparently only larva inhabits the space between the two sheathing leaves of the lia, and only those leaves which are full of a thick, brown, coffee- liquid are frequented. The pupa is inclosed in a rather tough, emely elongate, silken tube situated between the sheathing leaves. sts in an upright position in the midst of the semi-liquid mass. The measures about 38 millimeters in length, being very elongate with nead and the thorax unusually small. The two pronotal breathing s are shaped somewhat like a bivalve shell. Abdominal segments 6 at the base on the dorsal side have finely-toothed warts; the ventral ce has plain ridges. It is probable that the present species is not a Gnophomyia, but until more is known of this species and its relatives ould be referred to this genus.

ne *Gnophomyia pilipes* referred to by Beling (1879:42) and by Gerbig 3:161–163) pertains to Trimicra (page 932).

tristissima has been recorded by Malloch (1915–17b:230–231) as living et mud, but this is an error. The writer has material from exactly same source as Malloch's, received from James A. Hyslop, and this rs that the haunt of the larvae is beneath the decaying bark of trees — nusual habitat for one of the Eriopterini, which for the most part in damp sand or earth near water. The rearing of this species in York (by Young), Massachusetts (by Johnson), Maryland (by op), Virginia (by Shannon), Kansas (by Alexander), Illinois (by och and Alexander), and Texas (by Mitchell), leaves no question the immature stages are to be found beneath the decaying bark of arger hardwood trees, the tulip tree, *Liriodendron Tulipifera* Linn., g often preferred.

homyia tristissima O. S.

859 *Gnophomyia tristissima* O. S. Proc. Acad. Nat. Sci. Phila., p. 224.

ophomyia tristissima is an interesting black fly with conspicuous w halteres. It is common and widely distributed thruout the eastern

United States and Canada. As stated above, the species has been rea on at least seven different occasions in as many States, the most co plete account being that by Hyslop, whose specimens and manusc notes were kindly placed at the writer's disposal. His data on this spe are as follows:

May 14, 1914. Wolfsville, Maryland. Under the bark of a rotten stump of a t poplar (Liriodendron) on the roadside near Warrenfeltz schoolhouse, field on the left g to town. I found a great number of amber-yellow dipterous larvae (three in alcohol) also three pupae slightly shortened and with the thorax and legs ferruginous and the a men pale amber. They were in a very moist nidus of rotted inner bark; placed in rearin a tin box.

May 16. One adult emerged today (pinned); pupal case in alcohol.

May 18. Three adults emerged today (pinned); pupal cases in alcohol. Obse emergence of one adult. The swaying motion observed in *Tipula infuscata* was not obser but the adult simply glided straight out of the pupal case by a wavelike contraction of abdomen. The whole emergence took only about eight seconds. A larva pupated.

May 23. Adult emerged. Pupal stage five days. Placed the remainder of the pu (all had transformed from larvae to pupae) in alcohol. The pupae are quite active and m under a shelter if exposed. Just before emerging, the pupa takes on a black color on thorax and smoky yellow on the abdomen.

Shannon's material was reared from pupae taken under the bark o dead tulip tree at Dead Run, Fairfax County, Virginia, on May 1913. A larva that is undoubtedly this same species was found bene the same tree on April 17, 1913. Johnson bred this species from lar found beneath bark at Riverside, Massachusetts, on April 24, 19 The Texas specimens were found by Mitchell beneath the bark of cott wood (Populus) at Victoria, on June 30.

At Lawrence, Kansas, in 1919, the writer found a few larvae un the bark of a box elder, associated with the following dipterous larv *Pterocalla strigula* Loew, *Lonchaea laticornis* Meig., *Phaonia harti* M These associated species were kindly determined by Mr. Malloch. 1920 the flies were bred from under the bark of several deciduous trees Urbana, Illinois, by Mr. Malloch and the writer.

Well-preserved specimens of the larvae are not available to the writ and the following description is taken direct from Malloch (1915–17 230–231):

Larva.— Length, 9–11 mm. Slender, slightly tapering toward both extremities, m decidedly towards the cephalic. Body yellowish testaceous, covered with dense decumb pile.

Head [Plate LXXIV, 396] more compact than that of Helobia, the lateral rods stou antennae very small; maxillae large, produced beyond the apex of the narrow labrum, the p stout; labium not chitinized; mandibles slender, with a long sharp apical tooth and about t poorly defined teeth along the lower lateral margin. Locomotor organs consisting of ra

fusiform areas on anterior portion of abdominal segments except basal and apical; long margins of segmental incisions more distinct than elsewhere because of their lightly curved upward; anal segment with five processes, their structure and mark- in figure [Plate LXXIV, 397]; anal ventral blood-gills in the form of four short d protuberances.

e pupa is described from four cast skins, kindly presented by Hyslop:

a.— Length, 8–10 mm.

alic crest a low, blunt tubercle on either side of median line, each tipped with a long, eta. Labrum broad, elongate, obtuse at tip, completely separating triangular labial Sheaths of maxillary palpi moderately slender, tapering gradually to tip. Antennal moderately elongated, extending to about opposite wing root; basal segments angulate. al breathing horns (Plate LXXIV, 399 and 400) small, trumpet-shaped, very flattened, area lacking and hence the margins contiguous; just proximad of breathing horns , roughly triangular lobe on either side, immediately behind which are two small Mesonotum moderately declivitous, at crest rather tumid, but unarmed, with a rallel grooves on either side of median line; lateral angle of thorax very sharp, before n two setae, one very powerful, the more dorsal one abortive; a strong seta on either mesonotum behind crest. Wing sheaths short, ending just before tip of second nal segment. Leg sheaths (Plate LXXIV, 398) very short, ending just opposite tip nd abdominal segment and thus projecting but slightly beyond wing tips; hind legs the shortest, but no striking difference in length of various sheaths.

minal segments subdivided into a narrow basal ring and a much broader posterior bdominal segments on dorsum with four transverse rows of tiny but stout setae, two l ring and two on posterior ring, one being subbasal, the other subterminal, in position; n with only the subterminal row of setae present, but this well marked, the other erely vestigial; on either side of dorsum, just cephalad of ends of subterminal row e, a powerful bristle; in alinement with these and subequally spaced, two smaller strong pleural seta on a raised papilla opposite basal ring and three opposite posterior e two anterior being larger, the posterior one very small; sternum with a strong seta eme lateral margin of posterior ring; lateral spiracles distinct, on segments 2 to 7. auda (Plate LXXIV, 401) with ventral lobes small, blunt, rather widely separated but converging apically; dorsal lobes powerful, divergent, and rather acute at tips; of each near lateral margin a short bifid knob sending one arm dorsad, the other at base on cephalic angle a short, stout seta; two long, powerful, lateral setae on de, and a single powerful seta on either side of dorsum, immediately behind which nt tubercle. Female cauda with sternal valves elongate, powerful, at their tips ter- g in slender, divergent points; dorsal valves small, blunt, divergent, located at base al valves, at their tips with a short, slender spine directed backward; base of seg- bout as in male.

otype.— Wolfsville, Maryland, May 16, 1913. No. 234.

ypes.— Two male and one female pupae from type locality, May 18, 1913.

Genus Gonomyia Meigen (Gr. *angle* + *fly*)

1818 *Gonomyia* Meig. Syst. Beschr. Zweifl. Ins., vol. 1, p. 146.
1856 *Taphrosia* Rond. Dipt. Ital. Prodr., vol. 1, p. 182.
1869 *Goniomyia* O. S. Mon. Dipt. N. Amer., part 4, p. 176.

Larva.— Form elongate, terete. Spiracular disk surrounded by five blunt lobes which heavily marked with brown, in some species (*G. alexanderi*) the brown suffusing the between the spiracles. Head capsule of eriopterine type. Mandible with lateral slender, flattened. Antenna with apical papilla elongate-oval. Mentum not chitinized

Pupa.— Cephalic crest blunt, the surface with minute roughenings. Pronotal breat horns flattened, fanlike (*G. sulphurella*), or short, trumpet-shaped. Mesonotum declivi at crest with an interrupted transverse row of six to eight tubercles which are densely with sharp black spicules. Wing sheaths attaining base of third abdominal segment. sheaths moderately elongated, reaching base of fourth abdominal segment; tips of m tarsi ending a short distance before apices of other tarsi. Armature of abdominal segm weak. Lateral spiracles distinct, tubular. Five blunt, fleshy lobes on dorsum of ei abdominal segment.

Gonomyia is a large and diverse genus of small crane-flies (includ more than one hundred known species) described from all parts of world. They are divided into four recent subgenera, of which thre Gonomyia Meig., Progonomyia (new name for Gonomyella Alex., occupied), and Leiponeura Skuse — occur in the Nearctic fauna.

The immature stages of the known species are spent in moist san earth, usually near water. In Europe, *G. tenella* Meig. (Beling, 1879 mention only) was found in August in damp, sandy earth along the ma of a dried-up brook.

The writer has found the immature stages of *Gonomyia* (*Leipone alexanderi* and *G.* (*G.*) *kansensis* in wet sand near rivers. *G. sulphu* and *G. subcinerea* O. S. occur in muddier and more stagnant conditi near ponds and small streams.

Not enough larvae are available for study to require a key at time. The pupae of the known Nearctic species may be distinguished the following key:

1. Pronotal breathing horns narrow at base, expanded distally into a very flattened, like blade with delicate and anastomosing nervures.....*G. sulphurella* O. S. (p.
   Pronotal breathing horns not as above, more earlike or trumpet-shaped.....
2. Pronotal breathing horns massive, trumpet-shaped; lateral margin of thorax b wing root produced into an angle; male cauda small, elongate, dorsal lobes a shorter than ventral lobes, with two stout lobes on dorsal side far removed from base.....*G. alexanderi* (Johns.) (p.
   Pronotal breathing horns flattened, earlike or narrowly trumpet-shaped; lateral ma of thorax above wing root broad and blunt; male cauda short, stout, dorsal and ve lobes subequal in length, the latter closely approximated along median line, the fo widely separated, at their base with two acute points.....*G. kansensis* Alex. (p.

genus **Leiponeura** Skuse)

889 *Leiponeura* Skuse. Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 4, p. 795.
915 *Lipophleps* Bergr. Psyche, vol. 22, p. 55.

myia (*Leiponeura*) *alexanderi* (Johns.)

912 *Elliptera alexanderi* Johns. Psyche, vol. 19, p. 3.

ne beautiful crane-fly *Gonomyia alexanderi* is locally common in the ern United States. The adult flies may be swept from rank vegetation ne neighborhood of streams. When resting, the adults have a char- ristic position, the fore legs standing straight ahead and almost llel, the middle legs extended laterally and slightly forward, the legs directed backward but widely divergent, and the wings folded the back. This is the characteristic resting position for the genus. larvae were found in some numbers in rather coarse sand, around l pools of water near the Sacandaga River, Fulton County, New York, une 5, 1914. The adults emerged on June 16, giving a pupal period ot more than eleven days and presumably much less. The description figures of the pupa are made from the cast pupal skin of the male.

va.— Length, 8.3 mm.
Diameter, 0.4–0.5 mm.

oration very pale yellow or yellowish white.

m terete, elongated, slender. Body with a sparse, pale pubescence, at posterior margins ments with a transverse erect ridge of stiff hairs. Spiracular disk (Plate LXXV, 403) flattened, almost pentagonal in outline, surrounded by five lobes; dorso-medi n mall, slender; paired lobes very short and blunt; margin between lobes almost straight feebly concave; when disk is partly closed, lobes appearing a little more prominent; l lobes a little larger than lateral lobes; lobes heavily suffused with brown; on ventral a lateral dark brown line running dorsad to near spiracles, at its dorsal end connected disk by a paler brown suffusion; proximal stripes of ventral lobes shorter and paler, their inner ends with a small brown spot; lateral lobes almost entirely suffused with , this entirely surrounding spiracles and in some specimens entirely suffusing disk en spiracles, this mark bifid at its distal end; dorsal lobe indistinctly marked with ale brown; disk margined with short, pale hairs which are not interrupted and are little longer at tips of lobes. Spiracles widely separated, the distance between eing three or four times diameter of one; spiracles yellow, centers pale brown.

d capsule as in the tribe, the ventral bars broader than the slender dorsal bars, their nds not expanded or toothed to form the mental plate. Labrum-epipharynx moder- longate, densely hairy. Mentum not chitinized; hypopharyngeal region a cushion, d with delicate, short setae. Antenna as in this tribe, basal segment moderately elon- ensely hairy, apical papilla rather small, elongate-oval. Mandible (Plate LXXV, 402)

moderately large; apical point elongated, slender; ventral cutting edge with three flatte teeth, gradually smaller from outermost toward base; outermost tooth flattened, a lit enlarged distally, about as long as apical point; basal tooth small, acute; a prosthecal appe age with a brush of hairs beneath it.

Pupa.— Length of cast pupal skin, about 5.5 mm.

Cephalic crest of two prominent lobes, blunt at tips, their surface granulated. Lal lobes blunt at tips. Sheaths of maxillary palpi moderately stout, tapering suddenly to sh apices. Antenna with basal segment very angulated. Pronotal breathing horns (F I XXVI, 408 and 409) massive, short, trumpet-shaped, flattened laterally, and here margi with an elevated ridge, along which are scattered the rows of breathing pores; mouth of trumpet wide. On thorax between breathing horns, large, rounded lobes which are minu granulated. Declivity of mesonotum (Plate LXXVI, 407) somewhat precipitous, at rather narrow crest with about six small tubercles which are densely beset with spicu along shoulder a similar, but more elongate, transverse welt; lateral margin of thorax be wing root projecting out as a sharp angle with a seta at its base. Wing sheaths reac end of second abdominal segment. Leg sheaths moderately long, attaining base of fou abdominal segment; fore legs a very little longer than hind legs; middle legs much short ending just beyond base of last tarsal segment of fore legs.

Abdominal segments divided into two narrow basal rings and a much broader poste annulus. Armature of abdomen very weak. Male cauda (Plate LXXVI, 410 and 411) sm elongate; ventral lobes a little longer than the short, blunt dorsal lobes; on dorsal face n end of eighth segment, two stout lobes pointed at the tips which are directed dorsad slightly caudad; eighth segment with a close pentagon of pale, slender lobes, the poste pair larger and closer together than the anterior pair, the median lobe the smallest.

Nepionotype.— Sacandaga River, Fulton County, New York, June 5, 1914.
Neanotype.— With type larva.
Paratypes.— Two larvae with type.

(Subgenus **Gonomyia** Meigen)

Gonomyia (*Gonomyia*) *sulphurella* O. S.

1859 *Gonomyia sulphurella* O. S. Proc. Acad. Nat. Sci. Phila., p. 230.
1869 *Goniomyia sulphurella* O. S. Mon. Dipt. N. Amer., part 4, p. 180–181.

Gonomyia sulphurella is a handsome little crane-fly which is ve common and widely distributed thruout the eastern and central Unit States. Larvae are not infrequent in mud along the banks of strea The writer has bred this species from larvae sifted from sandy mud fr the banks of Cascadilla Pond, Ithaca, New York, where they oc associated with numerous larvae and pupae of a tabanid (*Chrysops ind* O. S.), a stratiomyiid (*Odontomyia* sp.), and other forms. Larvae collect on May 14, 1913, emerged as adults on June 1. Adults have been rea as late as October 19 by E. A. Richmond.

pa.— Length of cast pupal skin, about 6.5–7 mm.

phalic crest small, blunt. Labrum triangular, apex obtusely rounded. Labial lobes rcular, outer margin rounded. Sheaths of maxillary palpi short and stout, at apex nly narrowed (Plate LXXVII, 414). Antennal sheaths angulated at segments, the extending to beyond base of wing. Pronotal breathing horns (Plate LXXVII, 413) extreme base expanded, the neck short, constricted, soon passing into a greatly ded and very compressed disk, the whole suggesting a fan or certain polypores; margin s disk entire or gently crenulated, and sloping from ventral side outward; surface finely d and reticulated. Mesonotum somewhat precipitous, crest (Plate LXXVII, 412) l, with rounded knobs arranged transversely along it, there being about eight isolated and a more elongate one along shoulders, these knobs covered with minute blackened es. Lateral margin of thorax above wing root forming almost a right angle. Wing hs ending opposite base of second abdominal segment. Leg sheaths comparatively ending opposite base of fourth abdominal segment; fore legs a little the longest, middle onspicuously shorter than the others.

dominal segments divided into two narrow basal rings and a broad posterior annulus. ture of abdominal segments weak, posterior ring with a narrow row of small black s before caudal margin; on basal ring a broad band of microscopic scabrous points ged in interrupted transverse rows, there being about seven or eight of these rows band. Spiracles small but distinct. Female cauda with tergal valves short, but little r than sternal valves, slightly upturned, ending in short, cylindrical tips; near base a small, blunt tubercle on either side; dorsum of segment 8 with five rather long, pale the anterior pair more slender and more widely separated than the posterior pair, which ometimes closely approximated.

anotype.— Cast pupal skin, Ithaca, New York, October 19, 1915.
ratypes.— Three pupae with type.

myia (Gonomyia) kansensis Alex.

918 *Gonomyia kansensis* Alex. Can. Ent., vol. 50, p. 158–160.

nomyia kansensis is a prairie species of the *cognatella* group and ars to be common along the Arkansas and Kaw Rivers in Kansas. ng pupae were found at Larned on August 1, 1917, in sand along banks of the Arkansas River, where they were associated with the cal sand-loving fauna, including Gelastocoridae, Saldidae, and Carab- (Omophron, Dyschirius, Bembidion, and Tachys). The observation small ant preying on a living pupa of this fly is discussed on page

pa.— Length of cast pupal skin, 6 mm.

ilar to *G. alexanderi* in most essentials but showing the following differences: anten- eaths strongly angulate at segments; a tubercle on ventral face of antenna at base, and er at inner cephalic margin of eye.

Pronotal breathing horns (Plate LXXVII, 415 and 416) flattened, earlike or very narrowl trumpet-shaped, with a thick marginal ridge, the disk restricted. Lateral angle of thora above wing root very broad and blunt, setiferous. Leg sheaths of fore and hind legs almos on a level, those of middle legs shorter, ending a little beyond midlength of last tarsal segmen of fore legs. Male cauda (Plate LXXVII, 417 and 418) with dorsal and ventral lobes ver short and blunt, subequal in length; ventral lobes closely approximated on median lin dorsal lobes widely separated at their base, with two small acute points directed stro: gl dorsad, divergent at their tips, each with two small setae on outer face near base; dorsum segment 8 with five lobes, the anterior pair a little more widely separated than the poster pair, the median lobe slender.

Neanotype.— Larned, Kansas, August 1, 1917.

Genus **Rhabdomastix** Skuse (Gr. *rod* + *whip*)

1889 *Rhabdomastix* Skuse. Proc. Linn. Soc. N. S. Wales, ser. 2, vol. 4, p. 828–829.

The genus Rhabdomastix includes nearly a dozen species, some o which have been previously described as Gonomyiae.

The immature stages of *Rhabdomastix schistacea* (Schum.) were foun by Beling (1886:195) in wet earth beside a stream in beech woods o May 6. The larva measures 6 millimeters in length; the greatest diamete is 0.8 millimeter. The body is strongly dilated in the anterior part an gradually narrowed behind. The integument is deep brownish yellow The spiracular disk is short and blunt, and has four very small, tuberculat teeth, the lateral pair lying somewhat more cephalad than the mor powerful ventral pair; spiracles small, circular, yellowish brown, separate by a distance about equal to four times the diameter of one. The pup has the mesonotal declivity provided with an interrupted crossrow o small, unequal, chitinized teeth.

(Subgenus **Sacandaga** Alexander)

1911 *Sacandaga* Alex. Ent. News, vol. 22, p. 349–352.

Rhabdomastix (*Sacandaga*) *flava* (Alex.)

1911 *Sacandaga flava* Alex. Ent. News, vol. 22, p. 351–352.

Rhabdomastix flava is a curious fly which is apparently related t Gonomyia but represents a quite different offshoot of the Eriopterini The writer believes that the larvae might be found in moist earth alon streams, but at present they are quite unknown. The following note

e swarming habits of this species have been published (Alexander, a:72–73):

une 13, 1909, I found the species swarming [on Sport Island, in the Sacandaga River, ork] and made the following observations: The species came out at about 7.45 d at 7.51 p.m. began its flight in under an elm tree at the northeast end of the The flight was generally forward, but continually from side to side for a few inches. ght was quite irregular, always toward the slight north breeze. The whole swarm often move away and return, a little later, to the first place. It swarmed within four the ground, generally much lower, averaging, perhaps, two feet. . . . The of individuals participating in the swarm was about twenty. Other species swarm-rby at the same time were *Chironomus hyperboreus*, var. *meridionalis*, Joh., and the es, *Ephemerella excrucians* Walsh, and *Siphlonisca aerodromia* Ndm.

Trentepohlia Bigot (named after J. J. Trentepohl)

54 *Trentepohlia* Bigot. Ann. Soc. Ent. France, p. 474.
11 *Mongomioides* Brun. Rec. Indian Mus., vol. 6, p. 296.
12 *Mongomella* Enderl. Zool. Jahrb., vol. 32, part 1, p. 61.

ntepohlia is a tropicopolitan genus including about fifty-five described s arranged in six subgenera — Trentepohlia Bigot, Anchimongoma Mongoma Westw., Plesiomongoma Brun., Paramongoma Brun., Teomongoma Alex. Of these species, fifteen are American and the nder are Old World forms. They are almost all species of delicate, al structure, with long, slender legs. It is an interesting fact that *pohlia* (*Mongoma*) *pennipes* has been observed by Jacobson (De re, 1911:50, and Edwards, 1912–13:211) to form chains on hori- spider webs, as is noted herein for Thrypticomyia (page 712) and hat similarly for Oropeza (page 982). H. K. Munro has sup- (*in litt.*) the following interesting notes on the habits of *Trentepohlia epohlia*) *humeralis* Alex. as observed in eastern Transvaal at the April, 1920:

inconspicuous when flying and resting. When flying resembles very much a small thistledown. Invariably settles on under side of twigs, leaves, and similar objects. found among bushy undergrowth, but also in grass. When at rest the wings are long back; very often on settling the insect moves itself up and down in the manner ong-legged harvest spiders (Phalangiidae). Slow flier.

ssil Trentepohlia, *T. cruciferella* (Ckll.), has been described from the t Bay Oligocene (Cockerell, 1917b: 373–374). Observations on the ure stages of three species are available.

(Subgenus **Mongoma** Westwood)

Trentepohlia (*Mongoma*) *pennipes* (O. S.)

1887 *Mongoma pennipes* O. S. Berl. Ent. Zeit., vol. 31, part 2, p. 204.

The immature stages of *Trentepohlia pennipes* have been described De Meijere (1911:50-51) as follows: Jacobson found the larvae Semerang, Java, in January, 1906, in decaying plant stems. The larva sent was 9 millimeters long and almost 1 millimeter in diam of cylindrical form, only slightly narrowed behind and brownish in c The head capsule was entirely retracted. The entire body was thi beset with fine, short, appressed hairs; in addition to these, on the ve side of each of the six intermediate segments were transverse swell where the hairs were shorter and even more numerous. Surroun the anus were four long, cylindrical, anal gills, each constricted in t or four places; if bent forward, the anterior pair would reach the mi of the penultimate segment of the body, the posterior pair being somew shorter. The last segment of the body was truncated, the lower an being somewhat produced and provided with a few somewhat lo hairs; the spiracles, situated in the upper part of the spiracular fi were relatively small and somewhat elongated.

The pupa (Plate LXXVIII, 419) was about 9 millimeters long, el gate, of a yellowish brown color, the abdomen for the most part brigh The thorax was almost smooth, with only a few short, brownish yel bristles. The abdomen, except on the anterior segments, was thickly with numerous tubercles. The apex of the abdomen had two short, th like projections, curved outwardly; beneath these were two sho tubercles, and four short tubercles formed a quadrangle on the dor of the last segment. The pronotal breathing horns consisted of t tened, leaflike lobes, the upper surface of which was scaly.

(Subgenus **Paramongoma** Brunetti)

Trentepohlia (*Paramongoma*) *bromeliadicola* (Alex.)

1912 *Mongoma bromeliadicola* Alex. Ent. News, vol. 23, p. 415–417.

Trentepohlia bromeliadicola and *T. leucoxena* have a larval hab which has not been found elsewhere in the family. They live in water that gathers in the leaf axils of tropical bromeliaceous pla

ding their immature stages in this habitat, where they are associated a remarkable fauna of other organisms. The adult females have valves of the ovipositor greatly elongated, and the writer has sug-ed elsewhere that this may be an adaptation for laying the eggs in habitat. *T. bromeliadicola* was reared in Costa Rica by Picado, se important paper (Picado, 1913) on the bromeliaceous epiphytes ains colored figures of the larva, the pupa, and the adult. From paper it is seen that the larva (page 356, figure A, and plate 13, e 4, of reference cited) is not unlike that of *T. pennipes*, described re, the four prominent anal gills of *T. bromeliadicola* (Plate LXXVIII, of this paper) being a notable feature in common, altho here the trictions are very numerous, there being twenty-five or thirty shown ne figure. The pupa (Picado, 1913:357, fig. 51, and pl. 13, fig. 2) the pronotal breathing horns (Plate LXXVIII, 421, of this paper) oximated on the median line, and the sheaths of the ovipositor (Plate XVIII, 423) greatly elongated to contain the elongated terebra of the within. According to Keilin (1913), the tegumentary glands of this are a provision against drought, which is the great source of danger rganisms living in this habitat.

tepohlia (*Paramongoma*) *leucoxena* (Alex.)

915 *Mongoma leucoxena* Alex. Ent. News, vol. 26, p. 29–30.

entepohlia leucoxena was reared by Knab in Mexico, from larvae d living in bromeliaceous plants quite as in the preceding species.

is Teucholabis Osten Sacken (Gr. *weapons* + *forceps*)

859 *Teucholabis* O. S. Proc. Acad. Nat. Sci. Phila., p. 222.

pa.— Form elongate, slender, terete. Body practically destitute of pubescence and Spiracular disk surrounded by three very broad lobes, a flattened ventral lobe and horter lateral lobes at the base of which are the small black spiracles. Gills four, y rounded and developed for propulsion. Head capsule of four elongate, slender rods tes, interno-lateral pair forked at about midlength. Mandible rather small, with about blunt lateral teeth. Antenna elongate, two-segmented.

pa.— Cephalic crest setiferous. Pronotal breathing horns short, blunt, closely applied rax. Mesonotum precipitous, at crest with two powerful hooks and smaller serrated near shoulder. Wing sheaths reaching end of second abdominal segment. Leg is reaching end of fourth abdominal segment, middle tarsi the shortest. Abdomen transverse row of setae before ends of segments.

Teucholabis is a rather extensive genus of small crane-flies (includi more than fifty described species) which find their center of distributi in the Tropics of the New World. A few species occur in Africa and t Oriental region. The genotype, *Teucholabis complexa*, is the only spec that has been reared (Johnson, 1900). Johnson's material was kind sent to the writer for study, and furnishes the basis for the follow descriptions.

Teucholabis complexa O. S.

1859 *Teucholabis complexa* O. S. Proc. Acad. Nat. Sci. Phila., p. 223.

Larvae of *Teucholabis complexa* were found by Johnson in considera numbers beneath the bark of a decayed oak below Avalon, New Jers on June 8, 1899. They commenced pupating about the 13th, the imagi continuing to emerge from the 22d to the 27th. This gives a pup duration of not more than nine days.

Larva.— Length, 9 mm.
Diameter, 0.55–0.6 mm.

Coloration pale yellowish white, spiracles conspicuously darker.

Form long and slender, body terete, tapering abruptly to the small prothoracic segme (Plate LXXIX, 424). Sutures between segments indistinct. Body practically destitute pubescence and setae. Spiracular disk (Plate LXXIX, 427) with a broad, flattened, vent lobe, which is very bluntly rounded to subtruncate at apex, and two very short, blunt, late lobes, at the base of which are the spiracles; spiracular disk without distinct markin Spiracles small; middle piece black, ring pale horn-color; spiracles rather widely separat the distance between them about equal to the long diameter of one. Anal gills (Pl LXXIX, 428) represented by four blunt, rounded lobes, which are apparently developed propulsion rather than for a respiratory function.

Head not easily distinguishable in material available for study. Head capsule consist of four long, slender, rodlike plates, the internal lateral pair forked at about midleng so that capsule ends in six rods. Epipharynx with numerous small spines. Antenna (Pl LXXIX, 426) two-segmented, basal segment elongate-cylindrical, apical segment sm ovate. Mandible (Plate LXXIX, 425) rather small, apical point inconspicuous, with ab three similar lateral teeth below it. Lobes of the maxilla blunt, stout, hairy, not extend far beyond tip of mandible.

Pupa.— Length, 6.5–6.6 mm.
Width, d.-s., 1–1.1 mm.
Depth, d.-v., 1.2 mm.

Coloration pale; head, thorax, and sheaths of appendages darker; eyes black.

Form slender, narrowed behind. Between antennal bases a prominent, two-parted cr each lobe somewhat truncated behind and bearing a single stout seta. Front above e

raised, two narrow lines on front, meeting below at a very acute angle. Eyes large smaller in female, the front correspondingly narrowed or broadened. Labrum short, ngular. Sheaths of labial lobes small, suboval, separated by tip of labrum. Sheaths llary palpi short, stout, straight. Antennal sheaths moderately long, extending to yond wing base; basal segments prominent, indicated on sheath as prominent ele-

Pronotal breathing horns short, blunt, anterior face closely applied to pronotum, ace free; at base a small rounded knob. Thorax very deep, precipitous, at crest LXXIX, 429) armed with two strong curved hooks, one on either side of median line; ilder laterad of these hooks, two prominent flattened plates whose margins are y serrated, the dorsal, or outer, plate being the larger and terminating in a large hook. Wing sheaths moderately broad, ending just before tip of second abdominal . Leg sheaths (Plate LXXIX, 430) long and slender, outer pair much the longest, about opposite tip of fourth abdominal segment, middle pair the shortest. tum with two strong setae.

minal segments divided into two annuli by an indistinct suture, anterior ring narrow; ring with a strong seta on pleural region; posterior ring with strong setae on dorsum num near caudal margin; three other setae on pleural region, two at about midlength ent, the third near base and more dorsal in position. Male cauda (Plate LXXIX, ddenly narrowed, terminating in two blunt ventral lobes and two acutely pointed bes bent strongly dorsad at their tips and bearing a short seta in notch on inner face pex; near base of cauda, on dorsum, a broad transverse swelling terminating in two eparated, slender tubercles, immediately cephalad and laterad of which is a long seta; ong setae on either side near base of cauda; posterior margin of segment 7 with two l, decussate setae on dorsum, and between them two small setae; another powerful r pleural region, and just inside still another smaller seta.

notype.— Avalon, New Jersey, June 8, 1899.
otype.— With type, June 14, 1899.
ypes.— One larva and one pupa.

Cladura Osten Sacken (Gr. *branch + tail*)

9 *Cladura* O. S. Proc. Acad. Nat. Sci. Phila., p. 229.

genus Cladura includes six known species — two from eastern North ca, one from western North America, and three from Japan. The *Cladura delicatula* Alex., of the mountainous regions of the north- n United States, differs from the genotype, *C. flavoferruginea* O. S., ral important respects and it is necessary to erect a new group to it. This group may, for the present at least, be considered as a us of Cladura, and the name *Neocladura* (Gr. *new + Cladura*) is ed. Moreover, the genera Crypteria Bergr. and Pterochionea Alex. sely related to Cladura, and the entire group are almost certainly the forbears of the subapterous genus Chionea Dalman. Neocladura

curiously combines the structural characters of Cladura, Pterochio and Crypteria. In the long basal fusion-segment of the antennal flagel and in the wing venation, it agrees with Pterochionea and, to a somew lesser degree, with Cladura. In the structure of the male hypopygi which has two slender pleural appendages, it departs widely from type of typical Cladura, Chionea, and Pterochionea, and agrees be with Crypteria, as well as with Conosia v. d. W. and Lecteria O Because of this combination of characters, Neocladura must be separ in some manner from Cladura in the strict sense. It must be borne mind, however, that the conspicuous difference in the structure of male hypopygium probably has a phylogenetic significance, and the flics may not be so closely united as this arrangement would indica

The habits of the adult flies of Cladura and Neocladura are gener similar. Both species fly in late summer and in the autumn. T often occur on dry, wooded hillsides remote from streams and o bodies of water. The habits of the adult flies of *Cladura flavoferrug* have been discussed by the writer in an earlier paper (Alexander, 1910: as *C. indivisa*). His observations, made near Gloversville, New York September 22, 1909, are as follows:

> I went to Simmon's Woods, southeast of Gloversville, New York, this afternoon, was very agreeably surprised at the occurrence, in large numbers, of this usually uncom insect. Near the entrance of the woods, where Simmon's Brook emerges, the insects found in numbers. At each step they flew out of the bushes to others farther away. are wary insects, and when sitting on the upper side of a leaf, slip over the edge and inverted from the lower side when alarmed by an observer. They present a very chara istic attitude, sitting on the leaf of a tree, with their wings folded flat over the abdomen the six long legs stretched out over the leaf. A few were taken in copulation; these all hanging on the under side of a leaf. Their habit of clinging to the under surface of a is quite remarkable and I found several by looking for them there.
>
> There were hundreds of specimens in the low bushes of the woods, usually on the l leaves of deciduous trees at a height of two or three feet. Sometimes they would a on hemlock, and, occasionally, in ferns near the ground. It was the only tipulid obse here to-day.

The eggs of *C. delicatula* have been taken from gravid females. T are comparatively few in number, but because of their unusual size t almost fill the entire abdominal cavity of the fly. These large eggs elongate-ovate in shape.

Cladura flavoferruginea O. S.

1859 *Cladura flavoferruginea* O. S. Proc. Acad. Nat. Sci. Phila., pl. 4, fig. 34.
1861 *Cladura indivisa* O. S. Proc. Acad. Nat. Sci. Phila., p. 291.

immature stages of *Cladura flavoferruginea* were discovered while aper was in press. A brief account of the larvae and pupae are here in order to complete the data.

larvae were found in Augurville Woods near Urbana, Illinois. occurred in soil which was baked hard and dry and which supported ly any other insect life. Associated with the larvae when first ered were larvae of a scarabaeid, *Xyloryctes satyrus*; a tenebrionid, *antha contracta*; a few dipterous larvae of the genera Sciara and Psilo- a; millepedes of the genus Spirobolus; and a few less common forms nal life. A layer of dead leaves and other decaying vegetable matter d the surface, but this had not prevented an almost complete drying the soil to a depth varying from six inches to more than a foot. nly other tipulid larvae characteristic of such dry soil are species of noptycha (page 828).

most conspicuous features of the pupa are its exceedingly small compared with the adult fly that emerges from it, and the entire protuberant pronotal breathing horns.

— Length, 10–10.5 mm.
Diameter, 1.2 mm.

ation light yellow thruout.

comparatively short and stout. Integument provided with a delicate appressed nce; no distinct setae. Basal annulus of abdominal segments 2 to 7 with a transverse microscopic points arranged in long transverse rows; last ventral segment with a flat- be covered with short setae, evidently an organ for shoving. Spiracular disk entirely lobes, the spiracles being located on the exposed dorso-caudal surface of the last nal segment. Head capsule relatively compact; frontal plate broad, only slightly d behind. Labrum quadrate, with conspicuous oval lateral arms. Antenna two- ed, terminal segment elongate-oval. Mandibles of a herbivorous type, with an apical nd two incomplete rows of teeth on inner, or cutting, face. Mental bars widely d, each bar provided with two acute teeth at its proximal end.

— Length, 6.7 mm.
Width, 1.4 mm.
Depth, 1.4 mm.

ation pale yellow; head, thorax, and appendages darkening in age.

lic crest gibbous, entire or feebly bifid, armed on either side with a single powerful wo bristles on vertex and two on front; labrum with a pair of small bristles at each lateral angle. Labial lobes subquadrate, weakly separated by apex of labral sheath. heaths short and stout, straight. Lateral margin of eye produced laterad into a n lobe. Antennal sheaths extending to opposite one-third length of wing sheaths. breathing pores entirely sessile. Pronotum and mesonotum armed with

conspicuous bristles. Wing sheaths ending opposite base of third abdominal segm Leg sheaths unusually long, ending opposite base of sixth abdominal segment; hind leg longest, middle legs the shortest. Abdominal tergites with ten strong bristles, eight l arranged in a single transverse row along posterior margin; abdominal pleurites with strong bristles, one on each anterior ring, two near caudal margin of posterior ring, ventrad of spiracle, the last-named rudimentary, located on segments 2 to 7; sternites un with bristles.

Genus **Chionea** Dalman (Gr. *snow*)

1816 *Chionea* Dalm. K. Vet. Akad. Handl., vol. 1, p. 102.
1912 *Sphæconophilus* Beck. Ann. Soc. Ent. Belgique, vol. 56, p. 142.

Chionea is a small genus of nearly apterous crane-flies, found thr the North Temperate Zone. All of the known species (about e have the wings reduced to mere vestiges, this being the only genu considerable size in which all the species show this condition. The S African genus Platylimnobia Alex., which shows a somewhat si condition of wing atrophy, is probably not very closely allied to Chio

The adult flies of Chionea are most often found walking awkwa over the snow in the late fall or early spring or during warm day winter. A few instances, however, have been recorded in which specim were found with the temperature below freezing. At other season the year they may be found among fallen leaves, under moss and sto in the nests of small mammals as Arvicola (Schmitz, 1914), or in dese subterranean wasps' nests (Schmitz, 1916, and Becker, 1912). Interes accounts of the habits of the adult flies of the commonest local spe *Chionea valga* Harris, are supplied by Ainslie (1906), Johnson (19 Washburn (1907), and others. Lugger (1896) gives the following inter ing account of the habits of the same species:

> As a general rule the wingless flies are found only early in the morning, though in one a female was discovered crawling over the snow in the evening. . . . A few winters the writer discovered a female moving slowly over the snow and by searching he soon det a male. Putting both together under an inverted glass the snow-flies immediately m notwithstanding it was several degrees below the freezing point. Soon afterward the f found a crack in the glassy surface of the frozen snow, and forcing herself into it s disappeared from view. Penetrating for some depth into the snow she deposited a nu of elongated eggs, which, however, did not hatch. Most females found seemed to hav eggs already fully matured and only lacked to be fertilized.

Frauenfeld (Brauer, Egger, and Frauenfeld, 1854:616) believed t the eggs are deposited in snow, since they are often laid in January February. He thought the slimy substance secreted by the small lat

les of the *receptaculum seminis* of the female acts as a covering to ect the eggs from wet and cold. It seems probable, however, that lies enter some crevice in the snow around the base of trees or shrubs reach solid earth, at least in some cases. Many authors have held flies to be nocturnal in their habits. Recently, Marchand (1917) furnished some interesting notes on an alpine Chionea, presumably *lpina* Bezzi. His observations and experiments showed him that nea was perfectly adapted to life on the snow, being attracted to medium by its bright light and white color, the contact of the cold ce on the feet resulting in a direct stimulus thru the claws. The ts drink water by pressing their proboscides against the snow. Mar- d considers the principal reason for these activities' being held on snow to be for the purpose of mating, since the insects can cover derable distances over the level surfaces and are much more visible ne another at this time. The copulation of this crane-fly has been described by Mik (Osten Sacken, 1887:196) as follows:

upper valves of the ovipositor prevent the male from getting on the back of the female; on its own back, in the direction of the longitudinal axis of the body of the female; the latter is walking it drags the male, who raises himself on his hind legs to an almost dicular position; this serves to explain the unusual incrassation of these legs.

e genotype, *C. araneoides* Dalm., is the only species whose immature s have been described.

nea araneoides Dalm.

316 *Chionea araneoides* Dalm. K. Vet. Akad. Handl., vol. 1, p. 104.

e present knowledge of the life history of *Chionea araneoides* is due st entirely to the work of Brauer, Egger, and Frauenfeld (1854). ebruary these investigators brought living adults, taken in copula, an unheated room and placed them with their natural surroundings, as rich, damp, humous earth, rotten grape leaves, and similar sub- es, in glass containers. After a time a great number of small, ated eggs of a hyaline appearance were noted, laid at random, some deposited on the walls of the container, where they adhered but shrunk and appeared dried out. Unfortunately the duration of the tage was not ascertained. Some weeks later the young larvae were l in the soil. They were of a cylindrical form, very pale yellow in and not especially active. They were associated with numerous

larvae of *Sciara longipes* Meig. Toward the end of May only a few larv were left, and these appeared fully grown but were not carried over in the pupal condition, which is still unknown.

Larva.— Length when fully grown, 7.4 mm.

Color light reddish yellow, contents of alimentary tract showing thru body. Body te (Plate LXXXII, 443), consisting of twelve segments, there being, besides the head, th thoracic and nine abdominal segments; last segment wedge-shaped (Plate LXXXII, and 447), obliquely truncated so that the surface slopes from behind upward. Two s acles on this oblique surface, with a paler brown, pincer-shaped mark between. M parts powerfully constructed. Mandible (Plate LXXXII, 444), produced into a long ap point; near midlength on inner edge of mandible a deep incision, distad of this about teeth, basad of it three teeth. Labrum quadrangular, with two lateral points on anterior p Mentum projecting outward as a cuticular rounded lobe. (Brauer shows two other appe ages which are toothed on the outer face [Plate LXXXII, 445, of this paper]; these proba represent part of the mentum, but from Brauer's figures they would appear to lie abo the labrum.)

Subtribe **Elephantomyaria**

Genus **Elephantomyia** Osten Sacken (Gr. *elephant* + *fly*)

1859 *Elephantomyia* O. S. Proc. Acad. Nat. Sci. Phila., p. 220.

Larva.— Form terete. Segments of body just before sutures with transverse rows of s hairs; abdominal segments 5 to 8 on ventral surface with a mouthlike depression surround by long, stiff hairs. Spiracular disk surrounded by four lobes, ventral pair the longe each of the latter bearing at its tip a single very long bristle. Spiracles moderately lar located at base of lateral lobes. Head capsule very long and narrow, the four plates v elongated. Mandible very small. Maxillary palpi short. Esophageal region surround by chitinized plates which are conspicuously obliquely ridged. Body of larva covered w numerous long, appressed hairs, producing a satiny appearance. Coloration saturat golden yellow.

Pupa.— Form slender. A small crest on vertex above eyes. Eyes very large, globul narrowly separated on frontal and vertical regions. Rostral sheath very elongated; pa recurved against it. Antennal sheaths lying across eye. Head and thorax with setifer tubercles. Abdomen with rudimentary lateral spiracles.

Elephantomyia is a small genus of crane-flies including about a doz described living species. These are found in widely separated regio of the world, there being about four in the East Indies, five in Afric and two in North America, one of which has been recorded also fro Europe. The genus is found fossil in the Baltic amber. The adu flies are remarkable for their very elongated rostra, and undoubted they feed on the nectar of tubular flowers as in the related genus Toxo

ı. No records are available, however, to indicate what species of ıts are thus frequented. The larvae live in decaying wood. The r species whose immature stages are known is the genotype, *Elephanto-a westwoodi*. The literature on the immature stages of this group lies is very limited, the only record being the unknown Limnobiine 1 of Malloch (1915–17 b:235–236), who gives a good description of larva. The pupa is here described and figured for the first time.

phantomyia westwoodi O. S.

1869 *Elephantomyia westwoodi* O. S. Mon. Dipt. N. Amer., part 4, p. 109.

Elephantomyia westwoodi is a rather common fly in eastern North erica. The adults are usually found in cool, shaded woods and may swept from vegetation in these localities. The larva lives in decaying d, as is shown by the three records available to the writer.

he larvae were found by Shannon in a very wet, rotten, willow log g near the tidal flat above the brewery at Rosslyn, Virginia, on May 1913. About eight larvae were found, well scattered thru the log. y were very active in their movements and were very beautiful, in being of a deep golden yellow color. These larvae were placed in ing, and adults issued on May 27 and 29 and June 5 and 7, indicating ıpal duration of a week or slightly less. Larvae were found in this also on November 23, 1912, and at that time they were almost grown, g about one-half inch in length. This shows that the species spends winter as almost fully grown larvae.

ohnson found these larvae near Edge Hill, Pennsylvania, on June 1899, and on May 25, 1905, in a log, just beneath the bark. Larvae pupae obtained by him were in the material studied in the preparation is paper.

Malloch found a single larva of this species in a much decayed log at te Heath, Illinois, on April 30, 1916 (Malloch, 1915–17 b:236).

va.— Length, 10–13.4 mm.
Diameter, 1.2–1.3 mm.

loration of body, a deep saturated golden yellow thruout.

dy moderately elongated, terete, relatively slender, tapering gradually toward either end nore noticeably and abruptly toward anterior end (Plate LXXX, 432); the three thoracic ents gradually increasing in size from the prothoracic backward. Abdominal segments 2 short, the third to the fifth the longest, remaining segments gradually shorter. Sur-

face of body densely covered with long, satiny, appressed hairs; thoracic and abdom segments with a dorsal and a ventral transverse ridge of short, stiff hairs just before cau margins of segments, these being longest on lateral parts of ridge; dorsal segments 6 7 with incomplete transverse rows at about midlength; on ventral surface of abdominal s ments 1 to 3, near base, two transverse rows of tiny spines with a depressed area betw segment 4 without this distinct double ridge; segments 5 to 7 with a very conspicu mouthlike depression at base of each, with a liplike margin on either side, the anterior m narrow with stiff hairs, the posterior margin swollen and densely set with tiny spines; on ment 8 the transverse mouth lying near end of segment, its anterior lip with a dense fr of long hairs directed backward. Spiracular disk (Plate LXXX, 434) surrounded by 5 lobes; lateral lobes the shortest, blunt at tips, inner face of each lobe slightly expan at tip, a few short silky hairs on outer face of lobe, inner face slightly chitinized; ventral l longer, broad, tapering gradually to obtuse tips, notch between lobes deep, V-shape narrow fringe of short, dense, golden, recurved hairs along outer face; at tip of each ve lobe a single long, powerful bristle. Spiracular disk unmarked. Spiracles large, widely separated, situated at base of lateral lobes.

Head capsule (Plate LXXX, 433) very small and narrow, the plates, four in numb being greatly elongated. (The exact details are difficult to see in the material available study.) Labrum broad, anterior margin evenly rounded, with a few long hairs. Epiphar geal region provided with long setae directed backward. Mandible very small, b narrowed, tip produced into an acute point with smaller teeth at about midlength. Me region feebly chitinized. Hypopharynx semicircular, rounded, anterior margin delica grooved. Esophageal region elongated, inclosed by chitinized plates provided with para ridges running outward on one side and inward on opposite face, upon focusing prod ing a latticed appearance. Maxilla densely hairy. Antenna two-segmented, conspicuo basal segment short, apical segment larger, suboval. Sides of capsule on swelling beh the maxilla with a brush of very long hairs. Plates of capsule elongated, expan and chitinized at tips and along margins; ventral plate near esophageal region w setae.

Pupa.— Length, 8.4 mm.
Width, d.-s., 1.1 mm.
Depth, d.-v., 1.3 mm.

Coloration light yellowish brown; abdomen darker; thoracic dorsum, sheaths of l and ovipositor more yellowish. (In younger pupae the coloration is more unifor pale.)

Form slender, body narrow. Eyes very large, rounded (Plate LXXXI, 441). Anten sheaths lying directly across face of eye. Vertex with a small but prominent crest ly transversely above eyes; cephalad of this crest and just proximad of the antennal base setiferous tubercle. Front between eyes moderately broad, produced caudad into the v elongate rostral sheath, which is transversely wrinkled. Sheaths of maxillary palpi recurv lying alongside rostrum. Sheaths of labium tiny, bilobed, lying at tip of rostrum. T long setae on front between eyes. Eyes very large, narrowly separated on dorsum of he the hinder part sunken under pronotum. Two conspicuous black tubercles behind anten bases, each bearing a long, stout seta. Pronotal breathing horns (Plate LXXX, 435) sm

clavate, yellow, constricted at bases, which are blackened; a prominent seta just above reathing horn; two setae on each side of pronotum beneath eye. Mesonotal prescutum y convex, with six strong setae on each side, one just cephalad of base of wing, another t of wing, and two semitransverse groups in front of and behind level of wing base. heaths short, ending some distance beyond tips of hind tibiae and just beyond base l abdominal segment. Leg sheaths (Plate LXXXI, 442) with fore femora strongly , lying alongside rostral sheath; tips of middle tibiae ending just beyond tips of fore legs very long, ending just before tip of fifth abdominal segment.

minal segments densely and microscopically punctulate. Segments 2 to 7 with two basal rings and a broad posterior ring. Setae of dorsal abdominal segments (Plate , 437) on the posterior ring consisting of a caudal series of two strong outer setae and aller inner ones, the outer one of the inner series close to the proximal one of the outer lateral series of setae powerful; basal series in alinement with anterior lateral seta, ng of two powerful outer setae and a delicate inner one; pleural segments with a rudi- y spiracle on segments 2 to 7, each spiracle with a stout seta above it; setae of ventral ts (Plate LXXX, 436) with two strong bristles on each side near posterior lateral mar- e outermost with a tiny seta above it; a single basal seta located on a level with ves- piracles. Female cauda (Plate LXXX, 439) with sternum of eighth segment having arp, curved, widely separated spines, and just laterad of these a stout seta; pleural with another seta on same level; sternal valves of ovipositor only a little shorter than alves; dorsum of segment 8 with two long teeth, above which are two slender, diver- bercles; tergal valves broad basally, narrowed suddenly at tip, on either side with a subapical seta. Male cauda (Plate LXXX, 438 and 440) with eighth sternite hav- trong median tubercle that is two-toothed; laterad of this a strong chitinized tooth a powerful seta on outer face; a similar strong lateral seta; eighth tergite with four tubercles arranged to form a square; ninth sternite blunt, each lobe ending in two ibercles; ninth tergite ending in two divergent lobes bearing at tip a large and a small d on dorsal face at about midlength another strong seta.

onotype.— Rosslyn, Virginia, May 21, 1913.
notype.— Edge Hill, Pennsylvania, May 25, 1905.
types.— Larvae with type larva (two) and with type pupa (two).

s Toxorhina Loew (Gr. *bow + nose*)

35 *Limnobiorhynchus* Westw. Ann. Soc. Ent. France, p. 683 (spurious name).
51 *Toxorhina* Loew. Linnaea Entomol., vol. 5, p. 400.
59 *Toxorrhina* O. S. Mon. Dipt. N. Amer., part 4, p. 109–114.
10 *Neoceratocheilus* Wesché. Journ. Linn. Soc., Zool., vol. 30, p. 358.

xorhina is a small genus including about nine described species, t all of which are from the New World. Two species occur in and one in India. *Toxorhina madagascariensis* Meun. is described African copal (Pleistocene). Nothing has been published con- g the immature stages of any member of this genus.

Toxorhina muliebris (O. S.)

1865 *Toxorrhina muliebris* O. S. Proc. Ent. Soc. Phila., p. 233.

Toxorhina muliebris is the commonest species of the genus in th United States, with a rather wide range thruout the Northeastern Stat The adult flies suck nectar from various flowers, such as the followin Rhamnaceae, *Ceanothus americanus* Linn. (Banks); Ericaceae, *Cleth alnifolia* Linn. (McAtee); Apocynaceae, *Apocynum medium* Gree (McAtee); Compositae, *Solidago canadensis* Linn. (Knab).

The immature stages are unknown, but from Mrs. Tothill's tent-tra observations they are presumably spent in mud, since adult flies we found in her traps set over wet, sedgy spots near Ithaca, New York. may be, however, that the insects live in fragments of decaying woo which might be buried in this mud, since such a habitat conforms mo closely to that of Elephantomyia, which is apparently closely related t Toxorhina.

Eriopterine No. 1

A very curious larva, which has not been reared, has been found various places near Ithaca during the past few years. It is a small, pal larva, very delicate and almost diaphanous in appearance, at the posteri end with five flattened black plates with serrated margins, and with it thoracic segments capable of considerable lateral extension. The larv is undoubtedly an eriopterine, but it introduces a type of spiracul disk that has not been found elsewhere in the tribe. The writer find it difficult to believe that this curious larva can belong to any of th eriopterine genera discussed in this paper, and yet there are very fe possibilities remaining; and one of these (Cryptolabis) does not occu in the habitat frequented by this larva. The genus Atarba, whos immature stages are still wholly unknown, is a possibility. Empeda, whic the writer considers to be a subgenus of Erioptera, has not bee reared and must also be considered as a possibility. If this is the larv of Empeda, the group at once assumes full generic rank as given it b Osten Sacken, but occupying an isolated position and no closer to Gon myia than to Erioptera. The larvae of this species were found commonl on Bool's hillside, at Ithaca, where they occurred in association wit numerous other crane-fly larvae discussed elsewhere (page 781). Th

is described here in the hope that it will be reared and its identity tained.

va.— Length, 7–8.2 mm.
Diameter, 0.4–0.5 mm.

oration pale yellowish white; skin very delicate, almost diaphanous.
ly moderately elongated, terete; meso- and metathoracic segments (Plate LXXV, 404) ghth abdominal segment capable of considerable expansion laterally, and, in death, y greatly swollen; last segment of body narrowed, cylindrical, with a number of long including a group of five near base of lateral lobes. A few scattered setae along abdom- egments. Spiracular disk (Plate LXXV, 405) surrounded by five equal elongate spatu- lades, these blades flattened, jet-black in color, margins finely toothed; paired lobes ase with a subhyaline median spot; margins of lobes (Plate LXXV, 406) with twenty- thirty hooks, recurved ones alternating with others laterally directed; when blades are these margins hooking closely together; at ends of blades and sparsely scattered along n, long, delicate setae; at apex of blades, two bristles; no spiracles found at base of Anal gills four, lateral pair elongated, telescopic, inner pair shorter.
d capsule much as in other eriopterine genera, especially Ormosia and Gonomyia, plates slender, ventral bars a little longer. Labrum as in the tribe; epipharyngeal with a large apical setiferous pad and two smaller pads nearer base. Mentum not d of ventral bars of capsule as in Molophilus. Hypopharynx a semicircular cushion d with long, dense setae, their tips a little recurved. Antenna with apical papilla ong for this tribe, about equal in length to basal segment, cylindrical, with tip rounded. ble moderately large, apical tooth not prominent, lateral teeth rather conspicuous, ones smaller but not so excessively reduced as in other members of the tribe; prostheca

scribed from larvae, Ithaca, New York, May 11, 1917. No. 29–1917.)

. *Tribe* Styringomyiini

e Styringomyiini comprise a small group of very peculiar crane-flies a tropicopolitan distribution. There is only the single genus, ngomyia, with about twenty-five described species. Most of the es are from tropical Africa and Asia, tho a few range into Australia the Hawaiian Islands, and one, *Styringomyia americana* Alex., is in tropical South America.

s Styringomyia Loew (Gr. *a kind of tree-gum + fly*)

45 *Styringomyia* Loew. Dipt. Beitr., vol. 1, p. 6. (Correctly *Syringomyia* — Bergroth *in litt.*)
03 *Idiophlebia* Grünb. Zool. Anzeig., vol. 26, p. 524–528.
12 *Pycnocrepis* Enderl. Zool. Jahrb., vol. 32, part 1, p. 65.
17 *Mesomyites* Ckll. Proc. U. S. Nat. Mus., vol. 52, p. 377.

The history of the genus Styringomyia is remarkable. It was erect by Loew in 1845, being based on the fossil species *Styringomyia venu* Loew, from African copal. Many years later it was found to be st living in the Tropics of both hemispheres. The earliest fossil recor pertain to the Oligocene of northern Europe (page 765).

The adult flies have such a curious structure that it seems best remove them from the former tribe Antochini, where they have long be placed. Concerning the first living species to be described, the Hawaii *S. didyma* Grimsh., Perkins (1913:clxxxii) says:

> It sometimes swarms at night around the electric lights, sitting quietly on the walls ceilings, with the body pressed closely to the surface, and the front and middle legs exten straight forward in front of the head in a characteristic manner.

Annandale has made similar observations on the resting positions of *ceylonica* Edw., taken in India. He says (cited by Edwards, 1914–15:207 "This species rests on walls with the two anterior pairs of legs stretch out straight in front and the posterior pair behind, resembling a str piece of cobweb." Jacobson has recorded much the same for *S. jacobs* Edw. (De Meijere, 1911:41–42, as *S. didyma*) in Java. The flies attracted to lamps and are almost always to be found in copulation, t head of one directed away from the other; while thus engaged, son times one, sometimes the other, will run forward for a short distan producing a peculiar appearance. Munro (*in litt.*) reports that the hab of *S. vittata* Edw. as observed in eastern Transvaal in late April, 19 are very similar. He writes: "Two specimens taken 'in cop.' Sett on under side of a twig, heads in opposite directions, front legs of ea stretched out in front along twig, wings laid flat along abdomen."

Styringomyia didyma Grimsh.

1901 *Styringomyia didyma* Grimsh. Fauna Hawaiiensis, p. 10.

In *Fauna Hawaiiensis*, Perkins (1913:clxxxii) mentions the breedi of *Styringomyia didyma* by F. W. Terry. Before the reference could investigated by the writer, Mr. Terry died. The following letters fr O. H. Swezey in regard to the matter were then received.

In response to a letter sent on February 21, 1915, Mr. Swezey repl on March 26 that "no information on the rearing of the species is availa in Mr. Terry's notes."

n a letter dated April 10 of the same year, however, the following es were enclosed:

bout forty-five eggs deposited in tube December 5, 1910. Chorion jet black, shining and k, resisting dryness, 0.3 mm. by 0.15 mm., very finely parallel-striate.
ne hatched December 10. The batch was placed with rotten apples and cow manure, hing December 15. Larva long, head small, mandibles distinct and well chitinized.
n adult male emerged about January 21, 1911.

Mr. Swezey, thru whose kindness the above notes are available, adds: ou see from the notes of Terry's that he did not breed *Styringomyia yma* in its natural habitat. That is yet unknown, I guess."

The striking feature of this life history is its brevity, the entire egg, val, and pupal stages being passed in about a month and a half. The ter knows of no other crane-flies in which this is equaled, its nearest roach presumably being in the smaller Eriopterini.

SUBFAMILY Cylindrotominae

The subfamily Cylindrotominae constitutes a small, isolated group of ne-flies, with twenty described species arranged in seven recent genera. the species are Holarctic in their distribution with the exception of species of the Oriental genera Stibadocera Enderl., Stibadocerella n., and Agastomyia de Meij. The group is a decadent one, having n much better developed in the early and middle Tertiaries than at sent (page 764).

he adult flies are sluggish in their habits, occurring on vegetation ool, shaded spots. The species of Cylindrotoma are brightly colored, ow and black, but the other forms are somber in appearance and k or dark in color, the body being in some cases highly polished or allic. The immature stages of the Cylindrotominae differ from those ll other Tipulidae, so far as is known to the writer, in being spent various bryophytic and spermatophytic plants, on the leaves of which larvae feed. The larvae are usually bright green in color and suggest terpillar in their general form. Most of them simulate their host ts to an astonishing degree. The immature stages of Cylindrotoma Liogma are terrestrial, while those of Triogma and Phalacrocera are atic or nearly so.

he genera of the subfamily Cylindrotominae may be separated as ws:

Larvae

1. Body appendages very long and filiform; aquatic ..... *Phalacrocera* Schin. (p. 96
   Body appendages short, leaflike or tuberculate .....
2. Dorsal appendages all simple, on the terminal abdominal segments in a single row; te
   restrial on spermatophytic plants ..... *Cylindrotoma* Macq. (p. 96
   Dorsal appendages with teeth on anterior convex side .....
3. Some of the dorsal appendages with three or four teeth on anterior face; aquatic
   mosses ..... *Triogma* Schin. (p. 97
   Dorsal appendages with one (*L. nodicornis*) or two (*L. glabrata*) teeth.
   Liogma O. S. (p. 96

Pupae

1. Basal abdominal tergites without spines .....
   Basal abdominal tergites with acute spines .....
2. Mesonotum unarmed; segments 6 and 8 each with two powerful dorsal hooks; segm
   7 with a pair of strong ventral spines; pronotal breathing horns elongate, direct
   backward ..... *Phalacrocera* Schin. (p. 96
   Mesonotum with two flattened erect lobes; segments 6, 7, and 8 naked; pronotal breathi
   horns small, directed slightly forward ..... *Cylindrotoma* Macq. (p. 96
3. Abdominal spines branched ..... *Liogma* (*glabrata*) (p. 96
   Triogma (*trisulcata*) (p. 97
   Abdominal spines not branched ..... *Liogma* (*nodicornis*) (p. 97

The most important literature on the Cylindrotominae is as follows:

General account of subfamily. Osten Sacken, 1897; Alexander, 1914:105–106; Malloc
1915–17 b:210–211; Lenz, 1920 b:113–115.

Phalacrocera replicata	Larva, pupa, general	De Geer, 1773; 1776:135–141, 35
Phalacrocera replicata	Larva	Grube, 1868.
Phalacrocera replicata	Larva	Engel, 1884.
Phalacrocera replicata	General	Giard, 1895 b.
Phalacrocera replicata	Larva, general	Bengtsson, 1897. (Morphology larva.)
Phalacrocera replicata	Larva, pupa, general	Miall and Shelford, 1897. (Mo phology of larva and pupa.)
Phalacrocera replicata	Larva	Bengtsson, 1899. (Morphology heart.)
Phalacrocera replicata	Larva	Holmgren, 1908. (Morphology head.)
Phalacrocera replicata	Larva, pupa	Grünberg, 1910:32–35.
Phalacrocera replicata	Larva, pupa, general	Wesenberg-Lund, 1915:343–347.
Phalacrocera replicata	Larva, pupa, general	Lenz, 1920 b:127–129.
Cylindrotoma distinctissima	Larva, general	Schellenberg, 1803:22–23.
Cylindrotoma distinctissima	Larva, pupa, general	Boie, 1838:234.
Cylindrotoma distinctissima	Larva, pupa, general	Zeller, 1842.
Cylindrotoma distinctissima	General	Schiner, 1864:563.
Cylindrotoma distinctissima	Larva, pupa, general	Kaltenbach, 1874:7.
Cylindrotoma distinctissima	Larva	Wesenberg-Lund, 1915:335 (as T ogma).
Cylindrotoma distinctissima	Larva, pupa, general	Lenz, 1920 b:115–117.
Cylindrotoma splendens	Larva, pupa, general	Cameron, 1918.
Liogma glabrata	Larva, general	De Rossi, 1876.
Liogma glabrata	General	Osten Sacken, 1878 a.

glabrata	Larva, pupa, general...	Müggenberg, 1901.
glabrata	Larva, general.....	De Rossi, 1902.
glabrata	General.....	Alexander, 1914:106–107.
glabrata	Larva, pupa, general...	Lenz, 1920b:117–121.
nodicornis	Larva, pupa, general...	Alexander, 1914:107–115.
a trisulcata	Larva, general.....	Steinmann, 1907–08.
a trisulcata	Larva, pupa, general..	Müller, 1908–09.
a trisulcata	Larva, general.....	Wesenberg-Lund, 1915:347–348 (as *Liogma glabrata*).
a trisulcata	Larva, pupa, general...	Lenz, 1920b:121–127.

s **Phalacrocera** Schiner (Gr. *bald* + *horn*)

63 *Phalacrocera* Schin. Wien. Ent. Monatschr., vol. 7, p. 224.

a.— Body covered with numerous elongate, trachea-bearing filaments, the posterior dorsal segments deeply forked, the others simple. Spiracular disk with dorsal pair s formed by rudimentary posterior branch of branched filaments of eighth abdominal t. Head capsule compact. Mentum with about fifteen teeth.

a.— Cephalic crest low, not setiferous. Pronotal breathing horns long, almost t. Dorsal abdominal segments with tubercles, those of sixth and eighth segments d into spinous hooks; two pointed tubercles on seventh sternite.

alacrocera is a small genus (four species) of medium-sized to large, olored flies, of which the genotype, *Phalacrocera replicata*, is Euro- *P. mikado* Alex. is Japanese, and the two remaining species are n American.

e adult flies of the American species are not common, the best-known, *ulina* O. S., being most frequently found in or near sphagnum bogs in tainous localities. Needham (1908a:209) found the wings of an indi- l of this species in the pitcher plant, *Sarracenia purpurea* Linn., in the ndack Mountains, together with the wings of four specimens of *Ele- omyia westwoodi* and numerous other insects. Most of the specimens ave been found by the writer were taken in close proximity to bogs.

e immature stages of *Phalacrocera replicata* have long been known, g been described by De Geer and other early workers on insect y. More recently the life history, anatomy, and morphology have discussed in commendable detail by several other writers (page 960). the larvae and the pupae are aquatic, living among submerged in quiet, but non-stagnant, water.

e immature stages of *P. tipulina* are very much to be desired, as dult shows some features in its organization not found in the other s of the genus.[6]

[6] larva of this species was discovered by J. Speed Rogers in 1920.

Bengtsson (1897) erected for this genus the group Erucaeformia, wh he considered as the primitive form from which the Nematocera and Brachycera have been derived. This group, of course, has no stand whatsoever.

Phalacrocera replicata (Linn.)

1761 *Tipula replicata* Linn. Fauna Suecica, 2d ed., p. 500–502.
1863 *Phalacrocera replicata* Schin. Wien. Ent. Monatschr., vol. 7, p. 224.

The larvae and the pupae of *Phalacrocera replicata* have been discus in such detail by Miall and Shelford, by Bengtsson, by Holmgren, by Wesenberg-Lund, that they are considered here only in general ter The habits of the immature stages have been discussed by many wri since the time of De Geer. They are oftentimes rather numerous am aquatic plants such as *Ranunculus fluitans* Lam., *Fontinalis antipyret* Linn., *Hypnum elodes* Schp., *H. exannulatum* Guenbel, and other spec feeding on these mosses and probably on other plants. These moss fr ments give a green tinge to young larvae when seen thru the nearly tra parent body wall. Older larvae are more opaque and are brownish gr in color, indistinctly striped with pale and darker. The larva is extrem sluggish, remaining almost motionless for hours. It clings to moss ste by its large anal hooks, and, thus secured, it often sways its body fr side to side as if to accelerate respiration. The larvae can go for l periods of time without fresh air. Miall and Shelford kept specim alive for two weeks in bottles completely filled with water, and fo long time in water that had been boiled. The larvae can live for a l time out of water. Progression thru the mats of submerged vegetat is accomplished by grasping with the mandibles and the anal hoo alternately. When alarmed the larvae curl into a rounded ball, af the manner of many caterpillars. The skin, and more especially the l body processes, are often covered with ectoparasitic organisms, s as algae and infusoria, on which small fresh-water mollusks, Pl orbis, have been observed feeding and creeping about over the body the larva. This coating of organisms, the body outgrowths, and the gene coloration of the larva, give it a striking resemblance to the mosses am which it lives. De Geer (1776:355) shows that the larva can end excessive cold. He placed four larvae in a vessel at the beginning winter, and examined them in the following May. During the wi

water in which the larvae lived had frozen into a solid mass, yet, nvestigating the jar in the spring, De Geer found two of the larvae alive and able to feed, and within a month both had pupated.

ıe larval habitat is in ponds in which a moss vegetation flourishes in which currents keep the water in constant motion. A female ras observed by Miall and Shelford (1897:360) depositing her eggs e leaf axils of a submerged moss. The eggs, about sixty in number, aid singly and adhere slightly to the moss; they are opaque, dark lor, and spindle-shaped, with the surface of the chorion irregularly d, and with a rosette-like micropyle at one end. Bengtsson, Müggen- and others believe that Phalacrocera has but a single brood in a the larval existence occupying about eleven months; Miall and ord, however, admit the possibility of a second brood. The egg requires from eight to twelve days and the pupal duration is seven ght days, according to Bengtsson. According to Miall and Shelford, upal period is considerably longer.

ıring the larval development there are numerous moltings, at least and possibly ten; the old larval skin is cast by a simple dorsal split ding from the first to the fourth segment. Just after emerging the egg the larva is from 2 to 2.25 millimeters in length and about nillimeter in diameter, excluding the body projections. The first l stage (Bengtsson, 1897) lasts until the second molting. The body ovided with ten pairs of long, delicate, threadlike, lateral projections, ı are located on the second to the eleventh body segments and are as long as the body. The other projections of the older larvae are y indicated. The attachment apparatus is placed immediately e the anus, and consists of from eight to twelve chitinized hooks, ed forward and arranged in an arcuated crossrow. The color of ody is white, almost transparent. The mouth parts show the mandi- without a prostheca and moving horizontally. The second larval lasts from the second until the fourth molting. The body appendages appeared and are clearly developed, resembling in appearance and ve length those of the definitive stage. The attachment apparatus st-anal. The body takes on a distinctly striped appearance. The h parts have the prostheca well developed on the mandibles, which ertically placed and therefore have an up-and-down movement. third larval stage represents the fully grown larva from the fourth

molt up to the time of pupation. Here the dorsum of the body is a di brownish green with more or less distinct brighter spots, and the ven is bright green in color. The mouth parts and the attachment apparat are as in the second stage.

The pupa is comparatively active, moving about by flexion of abdomen. Its usual position is vertical, with the tips of the breathi horns just reaching the surface of the water. This vertical position pupa maintains by grasping the vegetation with its caudal abdominal hoo At times the pupa descends beneath the water by clinging to the vegetati but a submergence of six hours causes asphyxiation. The pupal existe was determined by Miall and Shelford as eleven days. When the ad emerges, the cast pupal skin is left attached to a moss leaf by the dor abdominal projections at the posterior end of the body.

Larva.— Length, about 25 mm.

Young larvae distinctly greenish, especially on ventral side, this coloration caused, least in part, by contents of alimentary canal showing thru body wall; older larvae m opaque, brownish green in color; dorsum with an indistinct striping of brown and whiti ventral surface whitish.

Head entirely retractile within prothorax and usually so retracted except when larva feeding; opening transverse. Prothorax, viewed from above, roughly rounded, ante margin convex; on ventral surface traversed by a weak suture. Meso- and metatho narrow. Abdominal segment 1 indistinctly divided into two annuli, the more basal very narrow; abdominal segments 2 to 7 divided into a narrow basal ring and a much broa posterior ring, each of these annuli still further subdivided into two annulets. Body p vided with numerous elongate trachea-bearing filaments, both simple and branched, giv larva a very bristly appearance (Plate LXXXIII, 448), these spines arranged as follows: *terg* with both simple and bifurcated filaments; on posterior part of pronotum two short, sim filaments; on meso- and metanotum, two pairs of simple filaments; on abdominal segm 1, an anterior pair of simple, and a posterior pair of deeply branched, filaments; segme 2 to 7 with basal ring unarmed, posterior ring with an anterior pair of simple, and a cau pair of deeply branched, filaments; segment 8 with only a branched pair, anterior bra long, slender, posterior branch very small, its outer face heavily chitinized and form dorsal lobes of spiracular disk; *pleurites* with all the filaments simple; one on posterior p of prothorax, and on anterior part of each of the other two thoracic segments; poste filament on these latter nearly vestigial; two unequal filaments on first abdominal segme segments 2 to 7 with one filament on basal ring and two on posterior ring, the anterior the longest; segment 8 with a single rudimentary filament; *sternites* with all the filame simple; prosternum without filaments; meso- and metasternum with a strong filament n lateral margins; abdominal segment 1 with two pairs of filaments, posterior pair the lon and more widely separated; segment 2 with three pairs of filaments, anterior pair very sh segments 3 to 7 with four pairs of filaments and an additional median one, arranged as follo

airs of small filaments on basal ring, the anterior pair more widely separated, two of much longer filaments on posterior ring, the last pair more widely separated, longer, pped with blackish, between them a tiny median filament. Chaetotaxy as follows: es with four solitary setae along anterior margin of prothorax, and two setae just d of each dorsal filament of prothorax and posterior filaments of meso- and metathorax; inal segments with a seta laterad of each simple and branched filament; pleurites stiff seta at base, and out toward apices, of middle lateral filaments; sternites with a of about four stiff setae on either side of posterior ring of prosternum, and a single eta on either side of median line; meso- and metasternum with a lateral group of setae; laterad, and another at about midlength, of each of the posterior pair of ventral nts.

acular disk with ventral lobes elongate, slightly recurved, the posterior face intensely ned, chitinized, each lobe with two acute spines at tip, with two setae near them; seta on side of base of each ventral lobe; dorsal lobes as already described, the rudi- ry posterior branch of last furcate dorsal filament much smaller than in ventral lobes, osterior face heavily blackened; spiracular disk rhombic in form, white, and having the appearance of porcelain. Spiracles situated between bases of dorsal lobes. Skin spiracles capable of retraction so as to form a deep recess.

d capsule rather short, almost conical, formed of two large lateral plates and a some- smaller and shorter prefrontal plate. Mentum with an outer (ectolabial) part and er (endolabial) part; mentum a triangular or somewhat pentagonal plate, strongly zed, fore margin with about fifteen teeth; mandibles working against teeth of both and ectolabia. Antenna of a single segment, bearing on its truncated apical end a nsory papillae. Mandibles small but strong, curved inward at tip and furnished with e of setae, which assist in closing the mouth opening. Maxilla expanded into flattened, -like structures, inserted high on side of head; palpus with a number of sensory papillae , and with a porous plate on outer side which seems to be an organ of hearing.

a.— Length, 16–18 mm. (Miall gives length up to 20 mm.)
Width, d.-s., 2.9–3.3 mm.
Depth, d.-v., 2.7–2.9 mm.

ration greenish brown, in alcohol a paler yellowish brown; a very broad dorso-median rown stripe which is narrowly margined laterally with yellowish; dorsum of abdomen d sublaterally with dusky, extreme lateral margins of body yellowish; ventral surface wo broader sublateral stripes and a very narrow ventro-median stripe.

erior end of body very deep and thick, as is usual in this group of crane-flies. Abdomen depressed, with lateral margins very thin and flattened. Cephalic crest low, non- ous, located between antennal bases. Labrum broad basally, narrowed toward apex, is broadly rounded; two setae at base of labrum. Labial lobes subcircular in outline. ary palpi elongate, bent strongly backward so as to lie along flattened cheek. Antenna elongated, extending far beyond origin of wing pad (Plate LXXXIII, 449). Thorax eep, flattened above. Pronotal breathing horns, which are broken in the writer's speci- seen from other descriptions to be rather elongate, almost straight, and slightly ent; two small setae between bases of breathing horns; two groups of setae on anterior f pronotum before breathing horns. Mesonotum (Plate LXXXIII, 449) with six

small, setiferous tubercles, one above each wing axil, the other four arranged in a trape on dorsum with the anterior pair closer together; metanotum with six setiferous tuber four of which are median in position, the other pair at antero-lateral margin, near ba halteres. Wing sheaths ending about opposite apex of second abdominal segment. sheaths ending before apex of third abdominal segment.

First abdominal segment similar to metanotum; segments 2 to 7 indistinctly subdi into a narrow basal ring and a much broader posterior ring; basal ring unarmed excep a seta on pleural margin and a trapezoid of tubercles on sternum; posterior annulus a as follows: tergites with four tubercles arranged in a quadrangle and located in the median stripe, posterior tubercles with a stiff seta just laterad of each; a lateral seta line with anterior tubercles; two lateral setae on a level with posterior tubercles, the pro one considerably the larger; these setae located in the yellow sublateral stripe; pleural m with two setiferous tubercles with an acute subappressed spine between them; a seta imm ately ventrad of anterior tubercle; on segments 6 and 7, spine closer to caudal marg segment, and tubercle beyond it lacking; sternites with a trapezoid of naked tubercle basal ring, posterior pair the closer together; a trapezoid of larger setiferous tubercle posterior ring, anterior pair the closer together; posterior punctures each having two s with an additional slender seta laterad of these in the lateral dark stripe; dorsum of seg 6 (Plate LXXXIII, 450) with posterior pair of tubercles replaced by two powerful directed caudad and laterad; segment 7 unarmed on dorsum, sternum with two acute sp near caudal margin; segment 8 with lateral angles produced dorsad into slender lobes w are spinous on all the faces; caudal angles directed caudad into slender lobes, acute a and with anterior inner face spinous and bearing a few setae. Male cauda with st valves very blunt and rounded, on either side of ventro-median line produced caudad int acute spine. Female cauda with dorsal acidothecae a little longer than the more sle sternal valves, both pairs much exceeded by caudal angles of eighth segment.

Nepionotype.— Larva, Denmark.
Neanotype.— Pupa, Denmark.
Paratypes.— One larva and one pupa.

(The writer is indebted to Dr. C. Wesenberg-Lund for this mate as well as for several other interesting European crane-fly life histori

Genus **Cylindrotoma** Macquart (Gr. *cylinder* + *I cut*)

1834 *Cylindrotoma* Macq. Suit. à Buff., vol. 1, Hist. Nat. Ins., Dipt., p. 107.

Larva.— Body covered with simple tubercles, a median dorsal row and a double ver row. Spiracular disk large, surrounded by small lobes. Head capsule compact. Men with about fifteen teeth.

Pupa.— Pronotal breathing horns short, cylindrical, directed strongly ventrad. M notum with two flattened lobes directed cephalad. Abdomen unarmed with spines or l

Cylindrotoma is a small genus including six species distributed thru the North Temperate Zone, three of these species occurring in N America.

e adult flies of *Cylindrotoma tarsalis* Johns., the only species that riter has ever found in nature, are common on rank vegetation in boggy, and swampy woods. The immature stages of the genotype, *stinctissima* (Meig.), have long been known, having been discussed chellenberg (1803), Boie (1838), Zeller (1842), Kaltenbach (1874), thers. The larva shows some resemblance to that of Phalacrocera, s almost entirely terrestrial in its habits, feeding on the leaves of us spermatophytic plants such as *Caltha palustris*, *Anemone nemorosa*, *nculus repens*, Chrysosplenium, *Stellaria nemorum*, *Sanicula europaea*, *biflora*, *Valeriana officinalis*, Allium, and others. It attains a length arly 25 millimeters, and is narrow, depressed, tapering to either end, f a grass-green color. There is a slight dorsal ridge from which a f short, fleshy spines projects, these spines being directed backward ne spine on each segment being longer than the others. There is a lateral margin bearing very short processes, and there are also pairs of ventral ridges without hooks and a pair of longer backward-ed processes near the anus. The pupa affixes itself to stalks or leaves e caudal end, to which the remains of the last larval skin adhere. arvae generally remain on the lower surface of the leaves, on which feed, gnawing holes in them. When about to pupate they generally their food plants and fasten themselves on grass blades and leaves by, usually pupating the following day. From the foregoing obser-ns it would seem that there are in the various localities two genera-a year, one in the spring and the other in the autumn.

e life history of *C. splendens* has recently been worked out in con-ble detail by Dr. A. E. Cameron, thru whose kindness the writer ceived specimens for study.

drotoma splendens Doane

00 *Cylindrotoma splendens* Doane. Journ. N. Y. Ent. Soc., vol. 8, p. 197.
00 *Cylindrotoma juncta* Coq. Proc. Wash. Acad. Sci., vol. 2, p. 401.
18 *Cylindrotoma splendens* Cameron. Ann. Ent. Soc. Amer., vol. 11, p. 67–89.

indrotoma splendens is an interesting crane-fly occurring from British mbia northward to Alaska. Dr. Cameron's excellent notes on the story of this species are abstracted in detail on pages 708 to 710 s paper. The following descriptions were made from material sent

to the writer by Dr. Cameron, a few details being added from Dr. Camer published notes.

Larva.— Length, 15–17 mm.
Width, d.-s., 2.4–2.5 mm.
Depth, d.-v., 1.5 mm.

Coloration light chlorophyll green, with two narrow, pale brown lines on dorsum, ext from posterior end, above spiracles, anteriorly, becoming more expanded and diffus fore part of body.

Body very depressed, both dorsal and ventral surfaces being flattened, lateral m sharp (Plate LXXXIV, 453). Head completely retractile within prothorax. Skin deli reticulated and roughened. Thorax, viewed from above, semicircular in outline, ma with about four tubercles on either side, anterior pair the largest, separated by a V-s notch. Pronotum with an anterior pair of small tubercles and a larger median tu behind, directed backward; segments 2 and 3 each with lateral margins two-toothe anterior tooth the larger and more pointed; a blunt dorsal tubercle on anterior margi a larger one behind. Abdominal segments indistinctly divided into four annuli whic poorly delimited; the two basal annuli narrow and corresponding to basal annulus of crane-fly larvae, the third annulus the largest and bearing a slender lateral tooth: segments less distinctly divided serrately on lateral margin; dorsum of abdominal seg with a row of blunt median tubercles, there being four on each segment, the first very to vestigial, the third slender, the last the stoutest; on venter of abdominal segment 7, near posterior margin, a fleshy conical lobe (pseudopodium) on either side of media these being smaller on anterior segments (1 to 4), and much larger and paler on pos segments (5 to 7). Spiracular disk very large and flattened, obliquely truncated, surro by six small lobes, the dorso-lateral pair small, widely separated, the ventro-latera much larger, the ventral pair very small, slender. Spiracles very small, circular, w separated, the distance between them about equal to six times diameter of one.

Mouth parts with labrum linguliform, terminating in four teeth, external pair sm than internal pair. Mentum with seven teeth on either side of small median one, th and the third on either side being the largest. Hypopharynx with two rows of small Antenna two-segmented; basal segment elongate, pyriform; apical segment thimble-sh Mandible (Plate LXXXIV, 454) powerful; cutting edge with about five marginal teet two dorsal teeth; a large basal prostheca. Maxilla large; outer lobe fringed with stiff a few acute sensory bristles situated on elevated papillae, two on cardo, one on outer of maxilla; maxillary palpi short, cylindrical, apex obliquely truncated and provided numerous sensory knobs, on side near tip a circular porous plate (which as it appea Phalacrocera is suggested by Bengtsson as probably being an organ of hearing).

Pupa.— Length, 11.7–14 mm.
Width, d.-s., 2–2.8 mm.
Depth, d.-v., 1.4–2 mm.

Color of live pupa, leaf green; preserved specimens much paler, yellowish; pro breathing horns grayish white; margins of abdomen nearly translucent.

um narrow, apex evenly rounded. Labial lobes stout, separated by labrum, at tip ed and somewhat pointed. Maxillary palpi long and stout, just beyond base bent backward. Antennae rather short, bases not widely separated (Plate LXXXIV, Thorax very deep, much flattened anteriorly (Plate LXXXIV, 455). Pronotal ng horns short, cylindrical, slightly divergent, apex of each a little expanded. Meso- at declivity with two flattened plates, which are blunt and directed cephalad and laterad; above wing axil a smaller tubercle. Wing sheaths ending just before apex nd abdominal segment. Leg sheaths ending just before apex of third abdominal ; tarsi ending about on a level.

men strongly depressed, lateral margins carinate; segments distinct, unarmed, sub- into a narrow basal ring and a much broader posterior ring; segments 2 to 5 a little than segments 6 and 7. Male cauda with valves divided into two rounded lobes nall median notch. Female cauda with dorsal valves straight, a little longer and touter than the slender sternal valves.

onotype.— Westholme, Vancouver Island, B. C., May 15, 1917.
otype.— Female pupa with type larva.

Liogma Osten Sacken (Gr. *smooth + furrow*)

9 *Liogma* O. S. Mon. Dipt. N. Amer., part 4, p. 298.

.— Body covered with elongate, leaflike projections, dorsal ones with one or two n anterior convex face. Spiracular disk surrounded by four lobes. Head capsule t. Mentum with about fourteen teeth.

.— Metanotum and abdominal tergites with elongate spines, branched in *L. glabrata*, n *L. nodicornis*.

genus Liogma includes three known species, of which the genotype, *a nodicornis* (O. S.), is American. The adult flies of this species ggish, and are found resting on vegetation growing in and about l ponds and similar situations.

Europe the life history of *L. glabrata* (Meig.) has been worked out e Rossi (1876), by Wesenberg-Lund (1915:347–348), and in con- ble detail by Müggenberg (1901). The larvae were found in the near Berlin, in wet, grassy spots where the moss *Hypnum squarrosum* & Schp. occurs. The complete metamorphosis of the insect takes ear, the larval life requiring the greater part of this period. The age lasts from eight to ten days and the pupal stage from eleven to days. The duration of adult life is not known, but it is certainly occupying but a few weeks at the most.

r Berlin the flies emerge during the first half of July. The males first, the females later, and the latter are always seized in copulation

by the males just after they have forsaken the pupal skin and while s teneral and undeveloped. Each female lays about sixty eggs, and th are deposited singly on the leaves or branches, or attached lightly to axils of the leaves, of *Hypnum squarrosum*. Egg deposition begins fr one-half to one day after copulation, and may be extended, with nu interruptions of greater or less extent, thru a whole day. The eggs from 1 to 1.2 millimeters long, spindle-shaped, yellowish green in co the chorion with a reticulate sculpturing. After the accomplishment oviposition the exhausted female soon dies. The larvae when first hatc are 2 millimeters in length and do not yet possess the beautiful moss-gr color of the later stage. With the exception of the chitinized head caps they appear ashy gray. The numerous thornlike projections are to noted already in the same positions as those of the developed larva, do not show the branching of the later stages. In the autumn the you larva grows very slowly, and during the winter it is still very small a difficult to detect. In the spring the growth is greatly accelerated, a the larva becomes fully grown during the latter half of June. Wh attaining its growth the larva molts several times, probably at le eight — the number determined for Phalacrocera by Bengtsson. Pupat occurs in the moss where the larva happens to be. In its green co with brown blotches, the larva remarkably simulates its host plant s the effect of the shadows cast by the plant stems and leaves. The lar are extremely sluggish in their habits.

The American species *Liogma nodicornis* has been found in various mos of the genus Hypnum (Alexander, 1914). The immature stages of t species are discussed below.

The following keys separate the species of Liogma:

Larvae

Prothoracic segment bearing four conspicuous dorsal projections about on a line; meso- metathorax with two pairs of dorsal appendages, each bearing two lateral teeth in fr second abdominal segment with four dorsal appendages, the last two bearing two t in front (Palaearctic) ..... *glabrata* (Meig.) (p. 9

Prothoracic segment bearing four inconspicuous dorsal tubercles; meso- and metathorax w two pairs of dorsal appendages, the anterior pair small, both pairs simple; second abdom segment with four dorsal appendages, the last two bearing a single small tooth in f (Nearctic) ..... *nodicornis* (O. S.) (p. 9

Pupae

otal breathing horns directed cephalad and dorsad; mesonotum bearing two pairs of nes, the more anterior being the smaller, situated just behind breathing horns, posterior r the larger; metanotum with two pairs of spines; abdomen with first tergite bearing o pairs of spines, the first having two lateral branches, the second simple; second tergite ring two pairs of spines, the first with two lateral branches, the second with one branch; rd tergite bearing three pairs of spines, the first very short and simple, the second with o lateral branches, the third with one branch; tergites 4 and 5 with three pairs of branches, first two similar to those of third segment, the last possessing two lateral nches..... *glabrata* (Meig) (p. 969)

otal breathing horns directed cephalad and ventrad; mesonotum spineless; metanotum h one pair of spines; abdominal tergites bearing but a single pair of appendages, which unbranched and correspond in position to the last or more posterior of those of the ropean species..... *nodicornis* (O. S.) (p. 971)

ma nodicornis (O. S.)

865 *Triogma nodicornis* O. S. Proc. Ent. Soc. Phila., vol. 4, p. 239.
869 *Cylindrotoma nodicornis* O. S. Mon. Dipt. N. Amer., part 4, p. 301.
887 *Liogma nodicornis* O. S. Berl. Ent. Ztschr., vol. 31, p. 226.

ogma nodicornis, the only American species of the genus, is widely ibuted thruout the Northeastern States. The larvae are found in — *Hypnum cupressiforme* Linn. and related species. They are the sluggish of any crane-flies known to the writer, moving only with slowness and much of the time appearing to be quite dead. They l about among the stems of their host plant and probably never leave ven to pupate. The pupal duration indoors is not more than six . Further details of the life history are given by the writer in an er paper (Alexander, 1914).

va.— Length, 14.5–15 mm.
Width, 3 mm.
Depth, 2.5 mm.

or of live larva light green, the numerous spines covering the body darker; sides with black marks, the first on first abdominal segment, the last on seventh abdominal nt; the marks on ends the smallest and least distinct, the five intermediate marks and conspicuous; these marks all lying parallel to one another; posterior face of ventral surrounding stigmal field intensely black.

thorax in front (Plate LXXXV, 462) sloping from anterior end, on ventral slope provided iplike lobes, with a transverse slit from which head capsule is exserted; upper lip the , not strongly chitinized, provided with a few small, scattered bristles, these more ous on sides of lobe; lower lip not so high, with small, scattered bristles not arranged w as in *L. glabrata*; at angle of slit a small rounded lobe bearing a small bristle. Dorsal appendages reduced to a pair of lobes in front, separated by a space a little greater liameter of one, and a pair of smaller lobes behind, very widely separated; lateral body dages long, conspicuous; ventral body appendages not apparent. Meso- and meta- swollen and arched ventrally like prothorax; dorsal appendages two, a small conical

one in front and a much larger one behind bearing a small tooth in front and with its
directed backward; lateral appendages, viewed from above, two in number, anterior one
larger, directed sharply backward, the second smaller, conical; ventral appendages, view
from side, four, anterior pair the larger, posterior pair small, slightly behind the others.

Dorsal appendages of abdominal segments (Plate LXXXV, 457) as follows: first segment w
two pairs of appendages; anterior pair the shorter, conical, tips strongly recurved and bea
a tiny tooth on anterior face at about midlength; posterior pair much longer, with
bent strongly backward, a small tooth on anterior face at about one-third length from ba
segments 2 to 7 with four pairs of appendages, the first pair very small, conical, the sec
exactly similar but larger, the third and fourth pairs similar to appendages of first abdom
segment; the tiny anterior appendage largest on second segment, gradually becoming sma
toward end of body. Lateral abdominal appendages as follows: first segment with t
pairs of appendages, the first directed laterad, the posterior two more recurved and direc
caudad; segments 2 to 7 with four pairs of appendages, the first very small, situated at ante
lateral angle of segment, the other three subequal and directed caudad. Ventral abdomi
appendages as follows: first segment with three pairs of appendages, which are successive
larger from the short anterior one to the large posterior one; segments 2 to 7 with five pa
of appendages, the first three small, the fourth intermediate in size between them and
enlarged fifth pair. Eighth segment bearing spiracular disk and its lobes; dorsal side
field with a pair of long, slender lobes bent conspicuously cephalad. Spiracular disk (Pl
LXXXV, 461) small, oval, the two rounded-oval spiracles situated side by side and close to ea
other, inclined toward each other and capable of being closely appressed; ventral lobes
disk directed ventrad, inner faces of lobes with a conspicuous jet-black line, tip of each lo
ending in a sharp recurved hook. (Müggenberg regards these lobes as representing t
ninth abdominal segment.) Ventral surface of terminal segments with small protuberanc

Head completely retractile into first thoracic segment. Mentum (Plate LXXXV, 458) wi
about seven teeth on either side, terminal pair the larger, separated by a V-shaped not
Antenna (Plate LXXXV, 460) two-segmented, basal segment elongate-cylindrical, tip ve
short, thimble-shaped, with a diameter less than that of elongate basal segment. Mandil
(Plate LXXXV, 459 and 460) many-toothed on inner face, with a prominent basal prosthec
mandibles working vertically against teeth of mentum. Maxilla (Plate LXXXV, 458) wi
palpi very short, broad, basal segment chitinized, tip narrow, pale.

Pupa.— Length: male, 10.4–11.4 mm.; female, 10–13 mm.
Width, d.-s.; male, 2–2.2 mm.; female, 2.2–2.6 mm.
Depth, d.-v ; male, 1.9–2.2 mm.; female, 2.1–2.5 mm.

Living pupae with pronotal breathing horns light yellow, the terminal half a little mo
brownish; a brownish black mark on prescutum; abdomen greenish, more yellow behin
dorsal spines clear light green thruout or with tips in some specimens a little infuscate
(In pupae preserved in alcohol, the greenish colors are lost, the dark brownish black ma
of the mesonotal prescutum is irregularly U-shaped, with the arms of the U directed bac
ward, and the dark color is produced caudad and cephalad along the dorso-median li
there is a triangular or rounded black spot on either side of the scutellar lobe; on the metan
tum is a large blackish median blotch, which is continued cephalad onto the meson
postnotum; the abdomen has an interrupted brownish black longitudinal line along eith
side of the midline of the dorsum; the posterior margin of each tergite is suffused w

.) In old and fully colored pupae, bases of dorsal spines brown, with the tips paler; nd thorax with appendages brown, in some specimens very dark; abdomen yellowish. halic part of head very flat and broad, without spines but with a small, blunt tubercle en antennal bases. Labrum transversely wrinkled, narrowed to the bluntly rounded Labial lobes large, divergent, each lobe rectangular with angles rounded. Sheaths• cillary palpi rather long, curved strongly backward. Antennal sheaths rather enlarged, ed cephalad, bending around anterior margin of eye and thence directed caudad, just beyond knee joint of fore legs. (In older pupae, the peculiar nodose antennal nts of the adult show thru the sheath.) Pronotal breathing horns (Plate LXXXV, large, conspicuous, directed dorsad and laterad, the terminal half bent rather ly cephalad. Mesonotum transversely wrinkled. Metanotum (Plate LXXXV, 463) wo long, slender spines, arising beyond midlength of segment, directed caudad and y dorsad. Wing sheaths broad, reaching posterior margin of second abdominal seg- Leg sheath ending just before posterior margin of third abdominal segment; fore legs ortest, hind legs the longest.

ominal segments with a narrow basal ring and a broader posterior ring; segment 1 half as long as segment 2; tergites 1 to 7 with a pair of long, slender, spinous pro- s, shortest on anterior segment, longest on seventh segment, these projections arising ear caudal margin of segment, directed dorsad and caudad, those of anterior segment parallel, those of posterior segments more divergent; segments 2 to 7 having lateral s produced into three sharp spines, one on basal ring and two on posterior ring of egment, these spines directed laterad and caudad, the terminal spines more sharply l than the other two; abdominal sternites armed as follows: segment 3 with a small, cal spine on either side, these spines very widely separated, segment 4 with similar but larger and more prominent, segments 5 to 7 similarly armed but with another small spines about midlength of segment and much nearer midline of body, segments with a subbasal triangular pit on either side, these pits widely separated; eighth with caudal margin rounded, concave, the lateral angles produced backward, upward, ghtly outward as strong spines; suture on ventral surface incomplete; two small spines er side of middle line of body; posterior margin of segment produced caudad as two spinous projections. Male cauda with sternal valves rather long, tipped with two acute spines, in some specimens with two spines on one of the lobes and only one other; tergal valves a little rounded at tips, slightly longer than sternal valves. Female (Plate LXXXV, 465 and 466) with sternal valves slender, feebly notched at tips; valves broader, rounded at tips, and with a deep median split.

Lonotype.— Coy Glen, Ithaca, New York, May 8, 1913.
notype.— Ithaca, May 30, 1913.
types.— Larvae and pupae with types; others from Orono, Maine, June 17 and 19,

s **Triogma** Schiner (Gr. *three + furrow*)

63 *Triogma* Schin. Wien. Ent. Monatschr., vol. 7, p. 223.

.— Body covered with elongate leaflike projections, some of the dorsal ones with y as four teeth on anterior convex face. Spiracular disk surrounded by four lobes.
.— Dorsum of abdomen with elongate branched spines.

The genus Triogma includes but three known species, the genoty
Triogma trisulcata (Schum.) of Europe, *T. kuwanai* (Alex.) of Japa
and *T. exculpta* O. S. of the eastern United States. The last-nam
species is very rare and its habits are entirely unknown.

The first reference to the immature stages of *T. trisulcata* is by Steinma
(1907–08), who discusses the larva as that of an unknown species
Phalacrocera. The true identity of this insect was made known
Müller (1908–09). Steinmann found the larvae at Säckingen at the e
of April, fourteen days after the melting of the snow. They were fou
in mountain streams, attached to and living among the stems of
aquatic moss *Fontinalis antipyretica* Linn., to which they clung firm
by means of two strong chitinized hooks at the caudal end of the bod
The larva resembles to a startling degree the moss on which it liv
Along the dorsal surface are two rows of leaflike appendages, each of th
abdominal segments having three such appendages, of which the m
anterior one is the shortest and the posterior one is the longest. Th
anterior appendage is untoothed, the others have as many as four tee
on the anterior face. The pleural region likewise bears a row of leafli
structures, while the ventral surface shows a double row of small, knobli
leaflets. Thru the strong accentuation of the dorsal and the two later
rows, there is produced a copy of the ternate condition of the leaf arrang
ment in Fontinalis.

The larva of *T. trisulcata* (Plate LXXXIII, 452) is of a light green col
marked with darker blotches, and measures 19 millimeters in length. T
longest body appendage is 1.5 millimeters in length. Müller found larv
and also pupae. The pupa is characterized by the possession of somewh
similar appendages to those of the larva, the dorsal row showing t
peculiar branched condition found in the larva.

SUBFAMILY Tipulinae

The subfamily Tipulinae comprises a remarkably homogeneous asse
blage of usually large species. It is made up of a relatively few but
some cases very extensive genera, which are found thruout the wor
Efforts have been made in the past to maintain three tribes — t
Dolichopezini, the Ctenophorini, and the Tipulini. It has become incre
ingly difficult, however, to define these groups on the constant accessi
of exotic genera and species. A study of the immature stages likew

substantiate the validity of these groups, and, for the present t, or until other and better characters may be found, it is better inate the Dolichopezini and the Ctenophorini, founded, as they insufficient or sexual characters.

species of the Tipulinae include the largest crane-flies known, some species of Ctenacroscelis attaining a wing expanse of nearly 10 eters. In North America the largest species are representatives genera Longurio and Holorusia. The great majority of the species subfamily are well above the average in size, this feature alone sufficient to eliminate all but a very few of the other groups of ae. The smallest member of the subfamily Tipulinae known to ter is *Microtipula amazonica* Alex., of Brazil, in which the wing of le measures but 7.2 millimeters in length and is very long and . Practically all of the common local species of this group belong two genera Tipula and Nephrotoma.

immature stages of members of the subfamily Tipulidae are found de range of habitats. Some species of Tipula are almost entirely in the larval state. The majority of the known species live in arth near water, or beneath damp cushions of moss. Some, such peza, live in much drier mosses on exposed rocks. A rather con- le number of species (Brachypremna, Ctenophora, Dictenidia, and species of Tipula) live in decaying wood or beneath the bark of te trunks. Tanyptera lives in wood which is relatively sound, is represents the extreme development of this tendency in the

larvae are never very slender, and are usually very plump and In a few cases only is the body decidedly depressed. There is ite arrangement of setae on the body, there being none on the annulus of the abdominal segments except a single seta on the of either side. The spiracular disk is surrounded by six lobes, per not found in the Limnobiinae. In Dolichopeza the number ribed as being five, the normal number in the Eriopterini, but r features of the genus are essentially tipuline. In a few species nber of lobes is increased to eight. In the genus Tanyptera the e exceedingly reduced in size so that the caudal end appears almost nd exposed. The spiracles are always present and in some cases large. The anal gills are almost always present and are variously

developed according to the habitat. The head capsule is remarka uniform thruout the group, being broad, compact, and massive, with posterior incisions shallow and the prefrontal sclerite very large usually distinct. The labrum is usually conspicuous, transverse, v fringes of hairs. The mentum has from seven to nine teeth along anterior margin, and is deeply split behind but not completely divi The hypopharynx consists of a narrow, flattened plate, with the l lateral angles produced into strong arms and the anterior margin ha usually five teeth, the teeth being rarely more numerous and in s cases obsolete. The antennae are cylindrical, and are stoutest in wood-inhabiting species; in many species of Tipula and Prionocera are long and slender, the length being about four times the diam the apical papilla, in some cases obsolete, is usually very small an flattened. The mandibles are not large in proportion to the size the capsule; they have few teeth, in some species only a dorsal an ventral tooth in addition to the apical point; the prosthecal appen is variously developed. The maxillae are simple and generalized structure.

The pupae are fairly uniform in structure thruout the subfamily. tips of the sheaths of the maxillary palpi are strongly curved, or, in majority of species, actually recurved. The pronotal breathing horns variously formed, but in practically all species they are short, cylindri and with the tips but little expanded. In some genera (Longu Prionocera, and Tipulodina) the breathing horns are greatly elonga and, in some cases at least, are slightly unequal in length, the lo measuring nearly half the length of the body. In some genera, s as Prionocera and Holorusia, the horns are split at their tips into divergent flaps. The only short, clavate horns in the subfamily those of the genus Tanyptera. The mesonotum is often provided four or six variously developed tubercles. The abdominal segments almost always armed with transverse posterior rows of spines, t ranging in number from about four to twenty.

The large size of the larvae and the pupae will, as a rule, easily sepa this subfamily from almost all members of the Limnobiinae. The large members of the latter group are readily separated by the charac outlined above.

e following keys separate the genera of the subfamily Tipulinae:

Larvae

racular disk surrounded by five lobes; living in moss ..... *Dolichopeza* Curt. (p. 981)
racular disk surrounded by four or six lobes, or with lobes indistinct 2
racular disk with lobes indistinct; living in nearly solid or semi-decayed wood.
Tanyptera Latr. (p. 988)
racular disk with lobes distinct 3
racular disk with four slender, hornlike lobes ..... *Tipula* (*selene* Meig.) (p. 1016)
racular disk with six lobes 4
l gills pinnately branched ..... *Longurio* Loew (p. 990)
Aeshnasoma Johns. (p. 993)
l gills not pinnately branched 5
epenultimate segment of abdomen with a strong lateral tubercle.
Oropeza Needm. (p. 982)
epenultimate segment of abdomen without such a tubercle 6
rsum of head behind antenna with a slender, flexible spine; living in wood.
Ctenophora (*apicata* O. S.) (p. 986)
rsum of head without such a spine 7
es surrounding spiracular disk elongate, digitiform, fringed with long hairs.
Prionocera Loew (p. 995)
es surrounding spiracular disk less elongate 8
large (over 50 mm.); spiracular disk with the six moderately long lobes fringed with
ng hairs; mandible small, with a dorsal and a ventral tooth; found in western North
merica ..... *Holorusia* Loew (p. 993)
smaller; if large (*T. abdominalis*), the lobes surrounding disk bifid; mandible with
wo or three ventral teeth ..... *Tipula* Linn. (p. 998)
Nephrotoma Meig. (p. 1016)

Pupae

notal breathing horns very long, slender, the longest one nearly if not quite half length
body 2
notal breathing horns short, cylindrical or flattened, subequal in size 3
gth 40 mm.; longest breathing horn 18 mm.; maxillary palpi not recurved at tips;
enation with petiole of cell M_1 very short ..... *Longurio* Loew (p. 990)
gth 20 mm.; longest breathing horn 9 to 10 mm.; maxillary palpi recurved at tips;
enation with petiole of cell M_1 longer ..... *Prionocera* Loew (p. 995)
notal breathing horns short, compressed, deeply bicrenulated; living in wood.
Tanyptera Latr. (p. 998)
notal breathing horns cylindrical 4
illary palpi not recurved at tips 5
illary palpi recurved at tips 6
notal breathing horns with apices deeply split; mesonotum with two tubercles;
dominal segments with fourteen to thirty-four spines; found in Western States;
ing in mud ..... *Holorusia* Loew (p. 993)
notal breathing horns short, slender, apices not split; mesonotum with eight tubercles;
dominal segments with four powerful spines near posterior margin; found in Southern
ates; living in wood ..... *Brachypremna* O. S. (p. 984)
onotum with two spines; ventral abdominal spines six to eight; fore and middle tarsi
bequal, shorter than hind tarsi; living in wood ..... *Ctenophora* Meig. (p. 986)
racters not as above 7
onotum with a large, roughly triangular, reticulated area on either side of median
e; dorsum of cauda with four lobes ..... *Oropeza* Needm. (p. 982)
onotum unarmed or with four or six lobes; dorsum of cauda with six, or rarely four,
es ..... *Tipula* Linn. (p. 998)
Nephrotoma Meig. (p. 1016)

The most important literature on the Tipulinae is as follows:

Dolichopeza albipes	Pupa	Beling, 1879:44–45 (as *sylvicola*).
Dolichopeza albipes	Larva, pupa, general	Beling, 1886:189–191 (as *sylvicola*).
Tanyptera atrata	General	Perris, 1840:92; 1849:332.
Tanyptera atrata	General	Nördlinger, 1848.
Tanyptera atrata	General	De Rossi, 1882.
Tanyptera atrata	Larva, pupa, general	Gercke, 1884, Pl. I, figs. 12
Tanyptera atrata	General	Hermann, 1880.
Tanyptera atrata ruficornis	Larva	Gerbig, 1913:156–158 (as *Ctenophora flavicornis*).
Tanyptera fumipennis	Larva, pupa, general	Malloch, 1915–17 b:194–19 1919.
Dictenidia bimaculata	Larva	Bouché, 1834:32.
Dictenidia bimaculata	General	Zetterstedt, 1851:4023.
Dictenidia bimaculata	Larva, pupa, general	Weyenbergh, 1872.
Dictenidia bimaculata	General	Beling, 1873 b:575.
Dictenidia bimaculata	General	Czizek, 1913:102.
Ctenophora flaveolata	Larva, pupa, general	Réaumur, 1740, Pl. I, fig. 9
Ctenophora flaveolata	General	Zetterstedt, 1851:4016.
Ctenophora flaveolata	Larva, pupa, general	Weyenbergh, 1872.
Ctenophora pectinicornis	Larva, pupa	Bouché, 1834:29–31.
Ctenophora pectinicornis	General	Fischer von Waldheim, 18
Ctenophora pectinicornis	Larva, pupa	Weyenbergh, 1872.
Ctenophora pectinicornis	General	Zetterstedt, 1851:4014.
Ctenophora pectinicornis	General	Kaltenbach, 1874:202.
Ctenophora festiva	Larva	Kaltenbach, 1874:631.
Ctenophora festiva	Larva	Czizek, 1911:48.
Ctenophora nigricoxa	Pupa	Lundström, 1906:7.
Ctenophora apicata	Larva, pupa	Johannsen, 1910:32–33.
Ctenophora angustipennis	Larva, pupa, general	Anthon, 1908.
Ctenophora angustipennis	Egg, larva, pupa, injury	Lovett, 1915.
Aeshnasoma rivertonensis	Larva	Johnson, 1906:1–2.
Aeshnasoma rivertonensis	General	Johnson, 1907–12 [1909]: 116.
Tipulodina pedata	Pupa	De Meijere, 1911:64.
Holorusia rubiginosa	Larva, pupa, general	Kellogg, 1901, a and b.
Holorusia rubiginosa	Larva	Comstock and Kellogg, 19 54–62.
Prionocera fuscipennis	Larva, pupa, general	Malloch, 1915–17 b:199–20
Prionocera parri, supp (Palaearctic species)	Larva	Alexander, 1919 c.
Tipula caesia	General	Schiner, 1864:516.
Tipula dilatata	Larva, pupa	Beling, 1886:176.
Tipula dilatata	Larva, pupa	Czizek, 1913:169.
Tipula flavolineata	General	Staeger, 1840:23.
Tipula flavolineata	Larva, pupa	Beling, 1873 b:581–582.
Tipula flavolineata	Larva, pupa	Czizek, 1913:146.
Tipula fulvipennis	Larva, pupa	Beling, 1879:22–24 (as *lutescens*).
Tipula fulvipennis	Larva, pupa	Czizek, 1913:74.
Tipula hortensis	Larva, pupa	Beling, 1873 b:578–579.
Tipula hortensis	Larva	Gerbig, 1913:154–156.

hortulana	Larva, pupa, general	Beling, 1879:25; 1886:178–179.
hortulana	Larva, pupa, general	Czizek, 1913:96.
imbecilla	General	Loew, 1869:9.
irrorata[7]	Larva, pupa	Beling, 1873 b:586–587.
irrorata	Larva, pupa	Czizek, 1913:98–99.
lateralis	Larva, pupa	Beling, 1879:26–28.
lateralis	Larva	Gerbig, 1913:153–154.
lateralis	Larva, pupa	Czizek, 1913:128.
lateralis	General	Cameron, 1917:61.
lunata	Larva, pupa	Brocher, 1909.
luteipennis	Larva, pupa	Beling, 1886:181–182.
luteipennis	Larva, pupa	Czizek, 1913:143.
marmorata	Larva, pupa	Beling, 1886:182–183.
maxima	Larva, pupa	Beling, 1886:177–178 (as *gigantea*).
maxima	Larva	Gerbig, 1913:152–153 (as *gigantea*).
maxima	Larva, pupa	Czizek, 1913:70–71.
maxima	General	Wesenberg-Lund, 1915:335 (as *gigantea*).
micans[7]	Larva, pupa	Beling, 1886:183–184.
nigra	Larva, pupa	Beling, 1879:28–29.
nigra	Larva, pupa	Czizek, 1913:132.
nubeculosa	Larva, pupa	Beling, 1873 b:575–577.
nubeculosa	Larva, pupa	Czizek, 1913:113.
ochracea	Larva, pupa	Beling, 1873 b:582–583.
ochracea	Larva, pupa	Czizek, 1913:157.
oleracea	Larva, pupa	Del Guercio, 1914.
oleracea	General	Patterson, 1908.
pabulina	Larva, pupa	Beling, 1873 b:579–580.
pabulina	Larva, pupa	Czizek, 1913:86.
pagana	Larva, pupa	Beling, 1879:29–31.
paludosa	Larva, pupa	Beling, 1873 b:583–585.
paludosa	Larva	Gerbig, 1913:136–151.
paludosa	Larva, pupa	Czizek, 1913:136.
paludosa	Larva, pupa	Rennie, 1916; 1917.
parva, supp	General	Onuki, 1905.
peliostigma	Larva, pupa	Beling, 1879:33–34.
peliostigma	Larva, pupa	Czizek, 1913:159.
pruinosa	Larva, pupa	Beling, 1879:31–32; 1886:184.
pruinosa	Larva, pupa	Czizek, 1913:148.
rufina	Larva, pupa	Mik, 1882 a.
scripta	Larva, pupa	Beling, 1873 b:577–578.
scripta	Larva, pupa	Czizek, 1913:110.
selene	Larva, pupa	Beling, 1879:34–35.
selene	Larva, pupa	Czizek, 1913:160–161.
signata	Larva, pupa	Beling, 1879:32–33.
signata	Larva, pupa	Czizek, 1913:104.
simplex	General	Doane, 1908.
subnodicornis	Larva, pupa	Beling, 1886:185–186.
truncorum	Larva, pupa	Beling, 1879:24–25.

[7] *micans* is considered by Kertész and others as a synonym of *T. irrorata*, but Beling's descriptions indicate that he had two distinct species before him.

Tipula truncorum	Larva, pupa	Czizek, 1913:82.
Tipula unca	Larva, pupa, general	Beling, 1886:179–181 (as *l* *cornis*).
Tipula unca	Larva, pupa	Czizek, 1913:101–102 (as *l* *cornis*).
Tipula variicornis	Larva, pupa	Beling, 1886:173–174 (as *v* *licornis*).
Tipula variicornis	Larva, pupa	Czizek, 1913:122–123.
Tipula variipennis	Pupa	Beling, 1873 b:580–581.
Tipula variipennis	Larva	Beling, 1886:186.
Tipula variipennis	General	Westhoff, 1879.
Tipula variipennis	Larva	Gerbig, 1913:131–136.
Tipula variipennis	Larva, pupa	Czizek, 1913:91–92.
Tipula vernalis	Larva, pupa	Beling, 1879:25–26.
Tipula vernalis	Larva, pupa	Czizek, 1913:120.
Tipula vittata	Larva, pupa	Beling, 1886:186–188.
Tipula vittata	Larva, pupa	Czizek, 1913:78.
Tipula winnertzii[3]	Larva, pupa	Beling, 1873 b:585–586; 1 188–189.
Tipula winnertzii (Nearctic species)	Larva, pupa	Czizek, 1913:84–85.
Tipula abdominalis	Larva	Malloch, 1915–17 b:200–20 *Tipula* sp. 2).
Tipula arctica	Larva, pupa	Nielsen, 1910:57–59.
Tipula arctica	Larva, pupa	Alexander, 1919 c:18c, 19c
Tipula bicornis	Larva, pupa	Forbes, 1890.
Tipula caloptera	Larva	Needham and Betten, 190 575–576 (as *abdominalis*
Tipula cunctans	Larva, pupa, general	Hyslop, 1910 (as *infuscata*
Tipula cunctans	Larva, pupa	Malloch, 1915–17 b:204.
Tipula eluta	Larva, pupa, general	Hart, 1898 [1895]:212–214
Tipula eluta	Larva, pupa	Malloch, 1915–17 b:203.
Tipula serta (?)	Pupa	Malloch, 1915–17 b:205.
Tipula trivittata	Larva, pupa	Greene, 1909.
Tipula trivittata	Pupa	Malloch, 1915–17 b:204–2
Tipula ultima	Pupa, general	Needham, 1903:280–281 *flavicans*).
Tipula ultima	General	Caudell, 1913 (as *flavican*
Habromastix cinerascens	General	Skuse, 1890:95.
Nephrotoma analis	Larva, pupa	Beling, 1886:172–173.
Nephrotoma analis	Larva, pupa	Czizek, 1911:70–71.
Nephrotoma cornicina	Larva, pupa	Beling, 1879:39–40 (as *ir* *color*).
Nephrotoma cornicina	Larva, pupa	Czizek, 1911:76.
Nephrotoma crocata	Larva, pupa	Beling, 1879:40–41.
Nephrotoma crocata	Larva, pupa	Czizek, 1911:87.
Nephrotoma lineata	Larva, pupa	Beling, 1879:42–43 (as *his*
Nephrotoma lineata	Larva, pupa	Czizek, 1911:83–84.
Nephrotoma lunulicornis	Larva, pupa	Beling, 1879:41–42.
Nephrotoma lunulicornis	Larva, pupa	Czizek, 1911:61.
Nephrotoma maculata	Larva, pupa	Beling, 1879:36–37.
Nephrotoma maculata	Larva, pupa	Czizek, 1911:80–81.
Nephrotoma pratensis	Larva, pupa	Beling, 1886:175–176.

[3] Riedel (1913:25) considers *Tipula winnertzii* as a synonym of *T. truncorum*, but Beling's descri indicate that the larvae he had before him represented two distinct species.

rotoma pratensis ..... Larva, pupa ..... Czizek, 1911:85–86.
rotoma quadrifaria ..... Larva, pupa ..... Beling, 1879:37–39.
rotoma quadrifaria ..... Larva, pupa ..... Czizek, 1911:66.
rotoma ferruginea ..... Larva, pupa ..... Hart, 1898 [1895]:218–219.
rotoma ferruginea ..... Larva, pupa ..... Malloch, 1915–17 b:206.

Tribe Tipulini

Subtribe Dolichopezaria

ıs **Dolichopeza** Curtis (Gr. *long + feet*)

825 *Dolichopeza* Curt. Brit. Ent., p. 62.
830 *Leptina* Meig. Syst. Beschr. Zweifl. Ins., vol. 6, pl. 65, fig. 10.
846 *Apeilesis* Macq. Dipt. Exot., Suppl. 1, p. 8.

ıe genus Dolichopeza is a small group of flies including about a score ɔecies, most numerous in the Oriental and Australian regions. The ature stages of the European *Dolichopeza albipes* Ström, a species is very close to the American species *D. americana* Needm., have described by Beling (1879, 1886). He found larvae in and beneath cushions covering the piles of waste copper slag in the Harz Moun-. On June 11, 1878, larval and pupal material was taken from a ɔck of the Jungermanniales liverwort *Alicularia scalaris* Corda. The l period was found to be six days. Females were noted depositing their in these hummocks, and small swarms of males were observed dancing by. It appears that the larvae feed on the upper side of the moss ion at night, withdrawing into the interior at other times. A larva was d in earth, which shows that these larvae are not dependent on mosses. ıe larva is described by Beling (1886:189–191) as being about 12 meters long and 2.3 millimeters in diameter. The body is almost e. The color is a rather bright green, the dorsum being marked two zigzag dark brown stripes. The spiracular disk has but five ; the three dorsal lobes are long and narrow, the median tooth being ed by the apparent fusion of two teeth; the ventral lobes are very , are tuberculate, and have a small, dark brown, triangular mark e inner tip. There is a small dark cross-stripe at the base of each l lobe. The spiracles are small, are circular, and are separated by tance equal to about one and one-half the diameter of one. Beneath spiracle is a rather large, irregular, blackish brown spot. The anal are strongly protuberant. The pupa measures about 14.5 millimeters ngth and 2.5 millimeters in diameter. The pronotal breathing horns

are directed straight outward and finally downward. The eighth segm has a circle of four dorsal, four ventral, and two pleural spines, wh are finely bifid at their tips. The pupa is green, as is the larva, with sim angular dorsal stripes.

This is the only tipuline larva known to the writer with five lobes rounding the spiracular disk. This feature is the more remarkable w this larva is compared with that of Oropeza, apparently closely rel but with a normal tipuline appearance. The immature stages of o species of Dolichopeza and related genera will be of interest.

The resting positions of Dolichopeza are described on page 713 of paper, and the striking dissimilarities to Oropeza noted. It may be Oropeza is not so close to Dolichopeza as has been believed. Osten Sa (1886:157) describes the mating of a European Dolichopeza, presuma *D. albipes*, as follows:

> I had occasion to observe the copula (in Heidelberg, July 26); the female was hanging from some support to which it held on by its front legs; it bore the whole weight of the who was fastened to it merely by the forceps, hanging head downwards, with his legs stret out. I have seen Bittacomorpha copulate in the same manner.

Genus **Oropeza** Needham (Gr. *mountain* + *feet*)

1908 *Oropeza* Needm. 23d Rept. N. Y. State Ent. (1907), p. 211.

Larva.— Form somewhat depressed. A strong tubercle on sides of body before spirac disk. Spiracular disk surrounded by six lobes, the four dorsal ones slender, the ven pair blunt. Anal gills blunt. Head capsule of the tipuline type. Mandible blunt, with ab seven teeth. Hypopharynx five-toothed. Mentum seven-toothed. Coloration dark gr

Pupa.— Pronotal breathing horns elongate-cylindrical, slender. Mesonotum wit slightly elevated triangular area on either side of mid-dorsal line. Leg sheaths ending ab on a level, or fore legs a little longer. Abdominal segments with two stout pleural spi posterior annuli before margin with a transverse row of twelve or fewer spines.

Oropeza is a genus of crane-flies including ten described species, of which occur in eastern North America with the exception of th Japanese forms. The flies are common beneath dark culverts and brid in outhouses, in crannies and crevices of rocky cliffs, beneath overhang boulders along mountain streams, and in similar situations. The rest positions of the adult flies are discussed on page 712. Many species sh a notable predilection for resting on spiders' webs. The immature sta of *Oropeza obscura* are spent in dry moss, as discussed below. Ot species have been reared in sandy soil and in wet moss.

eza obscura Johns.

909 *Oropeza obscura* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 122.

r. Hyslop has sent to the writer, at various times during the past or three years, larvae of *Oropeza obscura*. Numerous larvae and pupal skin were found under dry moss (*Hedwigia albicans* [Web.] b.) on rocks in the South Mountains, Maryland, on November 4, , by H. L. Parker. They were associated with the larvae of a dascillid e, *Eurypogon niger* (Melsh.). Additional specimens were found in caying log, but the preferred habitat seems to be beneath moss. The green larvae are very sluggish.

a.— Length, 11–12 mm.
Diameter, 1.7–1.8 mm.

or dark brownish green, ventral surface clearer green.

n depressed; body short and stout. Dorsum covered with small, blackened points, cing the dark color of this region of the body. Segments much wrinkled, especially al ring. On each side of penultimate segment a stout tubercle which simulates dorsal f spiracular disk. Spiracular disk (Plate LXXXVI, 469) moderate in size, surrounded fleshy lobes, dorsal pair short and slender, lateral pair long and slender, ventral pair hort and blunt; ventral lobes sparsely fringed with short, black hairs, and with a pale area bearing a sensory bristle; inner face broadly suffused with brown; at base of lobes similar but smaller triangular brown marks; a dusky area ventrad of spiracles. les large, placed obliquely. Anal gills four, large and blunt, pale yellow.

d capsule of the massive tipuline type. Labrum broad, with a short, blunt lobe on side; median epipharyngeal region with dense rows of stout setae and two small e on margin; lateral lobes with about four or five sensory bristles or papillae of various Mentum (Plate LXXXVI, 467) seven-toothed, median point long and slender, a pro- ion of outer mental plate. Hypopharynx (Plate LXXXVI, 468) five-toothed, the ntermediate teeth the largest, lateral tooth on either side small. Antenna slender, rical, with apical segment very reduced. Mandible rather slender, with about seven teeth on margin. Maxilla with cardo large, triangular, with two setiferous punctures, termost very large and hyaline and with two long, powerful setae; lobes of maxilla l with dense hairs; palpus short, disklike, with a large group of tiny hyaline papillae x.

a.— Length of cast skin, about 12 mm.

ration brown; pronotal breathing horns dark blackish brown. (It is possible that pae when alive are dark green in color, like the larvae.)

rum triangular. Labial lobes large, separated by apex of labrum. Sheaths of maxillary hort and stout, apex recurved to beyond midlength. Antennal sheaths moderately ed. Pronotal breathing horns elongate, slender, cylindrical, tips a little expanded. otum on either side of median line with a large, roughly triangular, reticulated area s slightly elevated, with apex of triangle directed toward mid-dorsal line. Mesonotum

transversely wrinkled. Metanotum (Plate LXXXVI, 470) near anterior margin with a tra verse row of setiferous punctures, there being four on either side, the intermediate ones w two setae. Wing sheaths reaching base of third abdominal segment. Leg sheaths reach beyond midlength of fourth abdominal segment, fore legs a little the longest, hind l a little the shortest.

First abdominal segment on dorsum somewhat similar to metanotum, with a transv row of four punctures at about midlength, the lateral ones with two setae; rema abdominal segments (Plate LXXXVI, 471) subdivided into approximately equal basal posterior rings; on tergites, posterior ring with a transverse row of spines, basal ring unarm on sixth tergite, where best developed, spines on posterior ring numbering about twelve, a seta at each end of the row and two others interspersed; on anterior tergites, spines small; on seventh tergite spines large, elongated; on eighth tergite four powerful spine transverse alinement; on pleurites, a strong spine on each ring, that of basal ring de bifid and with a strong seta in notch thus formed; posterior ring with a single spine bear a long seta on its face; on sternites, condition generally similar to that on tergites, the sp a little more prominent but of about the same number, these spines slender at their slig curved tips and lacking on sternites 2 to 4. Female cauda (Plate LXXXVI, 472 and 47 with acidothecae elongate, contiguous, on either side of tergites at base with a power incurved hook; posterior margin of eighth tergite with four spines, lateral pair a little larger; ventral side at base with a median protuberance bearing two powerful lateral lo and two smaller chitinized spines which are directed caudad and ventrad; base of segm 8 with a crossrow of eight spines; posterior ring of segment 8 with a powerful spine lateral end.

Nepionotype.— South Mountains, near Myersville, Maryland, March 31, 1916.
Neanotype.— Hagerstown, Maryland, May 9, 1916; cast pupal skin in collection United States National Museum.
Paratypes.— Larvae from type locality.

Genus **Brachypremna** Osten Sacken (Gr. *short* + *trunk*)

1886 *Brachypremna* O. S. Berl. Ent. Ztschr., vol. 30, p. 161.

Larva.— Unknown.

Pupa.— Antennal segments enlarged at base. Antenna short. Sheaths of maxilla palpi short, not recurved at tips. Pronotal breathing horns short, slender, finely annulat Mesonotum with eight prominent tubercles. Leg sheaths reaching beyond midlength fourth abdominal segment, fore tarsi very short, other tarsi subequal in length. Abdomi segments each with four slender spines on posterior ring of both sternites and tergites, j before posterior margin; two pleural spines; eighth segment of male with four promine spinous lobes.

Brachypremna is a small genus, including but nine recent species fou in the Austral and Tropical regions of the New World. *Brachyprem eocenica* Meunier is described from the Baltic amber. The flies of t best-known species, *B. dispellens*, are known in parts of the Southe

es as "weavers." They frequent rather shady places and have narkable dance over three or four feet of vertical space, whence the e "king of the dancing tipulids" given them by Johnson. This es is the only one whose immature stages are at all known.

hypremna dispellens (Walk.)

860 *Tipula dispellens* Walk. Trans. Ent. Soc. London, n. ser., vol. 5, p. 333–334.
886 *Brachypremna dispellens* O. S. Berl. Ent. Ztschr., vol. 30, p. 162.

achypremna dispellens is the most widely distributed species of the s. It ranges from New Jersey southward thru North America, and South America as far as Argentina. A larva found by R. C. Shannon rotten log by a stream near Washington, D. C., on April 23, 1913, placed in rearing and emerged in May as an adult male of this species. badly mutilated pupal skin was preserved and is here described. part of the larva was preserved.

pa.— Length of cast pupal skin, about 18 mm.

oration brownish yellow; abdomen with a broad brown sublateral stripe on both ventral orsal segments; each of pleural spines set in a brown spot.

d small. Antennal spines very large and crowded at base, soon passing into the short, r flagellum. Labrum (Plate LXXXVII, 474) blunt. Labial lobes closely approximated, to appear as a single large, transversely rectangular lobe at end of labrum. Sheaths cillary palpi short, not recurved at tip. Pronotal breathing horn (Plate LXXXVII, 475) slender, curved, ringed with fine annuli, tapering gradually to the small apex; margin x set with breathing pores. Mesonotum with eight conspicuous, blunt, naked tubercles; ur intermediate tubercles larger, arranged in the form of a trapezoid; anterior median igh, conical, located rather close to mid-dorsal line. Wing sheaths reaching end of abdominal segment. Leg sheaths (Plate LXXXVII, 476) extending beyond mid- of fourth abdominal segment; fore legs very short, ending opposite base of third segment of other legs.

ominal tergite 1 with a pair of long, slender spines before posterior margin; segments 2 ubdivided into a basal and a posterior ring, the latter with a transverse row of four long, r spines before posterior margin, the seventh tergite with about six such spines; sternites , with four spines on posterior ring; pleurites with a slender spine on basal and posterior t base of posterior ring between spines, an indistinct, slightly protuberant spiracle. cauda (Plate LXXXVII, 477) narrowed, small, valves blunt; on dorsal side near base onspicuous lobes, each terminating in a slender, chitinized spine; a small acute spine on f ninth segment at base.

notype.— Cast pupal skin, Washington, D. C., May, 1913 (in collection of United National Museum).

Subtribe **Ctenophoraria**

Genus **Ctenophora** Meigen (Gr. *comb + to bear*)

1800 *Flabellifera* Meig. Nouv. Class. Mouch., p. 13 (*nomen nudum*).
1803 *Ctenophora* Meig. Illiger's Mag., vol. 2, p. 263.
1910 *Phoroctenia* Coq. Proc. U. S. Nat. Mus., vol. 37, p. 589.

Larva.— Body opaque, integument rather thick. Spiracular disk surrounded by six l

Pupa.— Sheaths of maxillary palpi recurved. Pronotal breathing horns long and sle Two spines on mesonotum. Fore and middle tarsi subequal, a little shorter than tarsi. Ventral abdominal segments with six to eight spines.

Ctenophora is a small genus including about sixteen nominal spe found thruout the Holarctic region. The larvae and the pupae oc in decaying wood. The early stages have long been known, having b described by Réaumur and De Geer.

In Europe, *Ctenophora flaveolata* (Fabr.) is described and figured Réaumur (1740) and by Weyenbergh (1872). *C. pectinicornis* (Lin is described or mentioned by Bouché (1834), by Fischer von Waldh (1838), by Zetterstedt (1851:4014), by Weyenbergh (1872), and Kaltenbach (1874). *C. festiva* Meig. was reared by Kaltenbach (1874:6 from larvae in decayed beech stems. *C. nigricoxa* Lundst. (*Malpig vittata* Meig., auct. Frey) was reared by Lundström (1906:7) from pu in rotten birch stumps. The immature stages of the various Europe species of Ctenophora are described as living in the wood of vari trees such as willow (Salix), birch (Betula), cherry (Prunus), and ot hardwood species.

In North America, *C. apicata* is described by Johannsen (1910) fr elm (Ulmus), and *C. angustipennis* Loew by Anthon (1908) in alder (Aln and in poplar (Populus). The latter species is recorded also as injur prune trees (Prunus) in Oregon, by Lovett (1915), who gives an excell account of all stages and the type of injury done. The female lays fr 200 to 400 eggs, which hatch in from nine to seventeen days and larvae tunnel into the surrounding dead wood. Here they feed and gr reaching maturity the following spring. Pupation takes place in burrows, the pupal stage requiring about ten days. Osten Sac (1877:211) supposed that the larvae live in the stumps of redw (Sequoia), but this has never been confirmed.

Ctenophora apicata O. S.

1864 *Ctenophora apicata* O. S. Proc. Ent. Soc. Phila., vol. 3, p. 46.

e larvae and the pupae of *Ctenophora apicata* that were described ɔhannsen (1910) have been studied by the writer in the collection e Maine Agricultural Experiment Station. They were collected at ɔ, Maine, on June 23, 1909, by Dr. William C. Woods. In 1913 vriter examined the stump from which they were taken, and found cast pupal skins.

e notes here given are taken partly from Dr. Johannsen's description ɔartly from the original material.

a.— Length, about 30 mm.

r white. Body stout, cylindrical. Antenna cylindrical, with an apical papilla. rsum of head behind antennae, a slender, flexible spine. Spiracular disk surrounded lobes, dorsal and lateral pairs slender, finger-like; ventral pair blunt.

a.— Length, 25–27 mm.
Length of breathing horns, 3 mm. additional.
Width, d.-s., 5.2 mm.
Depth, d.-v., 5 mm.

a somewhat similar to that of Tanyptera, differing as follows: Form stout; abdomen depressed. Sheaths of maxillary palpi strongly recurved at tips. Pronotal breathing long and slender. Mesonotum with a prominent tuberculate spine on either side of n line. Legs short, ending before tip of third abdominal segment; tarsal sheaths ending on a level, or those of hind legs a very little longer. Abdominal segments 5 to 7 with eight spines. Female cauda with six powerful ventral spines or tubercles and two tubercles on either side. Valves of ovipositor short, tergal valves a little longer than l valves.

ionotype.— Orono, Maine, July, 1909.
notype.— Orono, Maine, July, 1909.
atypes.— Numerous pupae in collection of Maine Agricultural Experiment Station.

s **Dictenidia** Brullé (Gr. *double* + *comb*)

33 *Dictenidia* Brullé. Ann. Soc. Ent. France, vol. 2, p. 401–402.
56 *Ceroctena* Rond. Dipt. Ital. Prodr., vol. 1, p. 186.
63 *Dicera* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 9, p. 216.

ctenidia is a genus of Palaearctic crane-flies including three species, hich one is European and the others are Japanese. The genotype, *nidia bimaculata* Brullé, is very well known. The immature stages escribed or mentioned by Bouché (1834), by Zetterstedt (1851), by nbergh (1872), by Beling (1873 b), by Czizek (1913), and by other igators. Beling found the larvae in decaying birch (Betula). He bes the larvae as being grayish yellow, with four spiracular lobes. pupal duration is seven days. Osten Sacken (1886:173–175) states he has often found larvae in the wet detritus underneath the bark

of decaying trees. The larvae are much closer to Ctenophora than Tanyptera, the skin being tough and opaque, with a fine pubescence, a the spiracular disk consisting of small but distinct lobes. The pupae lik wise are similar to those of Ctenophora, having the pronotal breathi horns elongate, five spines on abdominal sternites 3 to 6, and four spines tergites 2 to 7.

Genus **Tanyptera** Latreille (Gr. *extend + wing*)

1805 *Tanyptera* Latr. Hist. Nat. Crust. et Ins., vol. 14, p. 286.
1832 *Xiphura* Brullé. Ann. Soc. Ent. France, vol. 1, p. 206.

Larva.— Integument very thin, with numerous setae, those on dorsum very sm Spiracular disk with lobes practically lacking. Spiracles large, lying exposed on the fac last segment. Anal gills bluntly rounded. Mandible small, with one dorsal and one ven tooth. Antenna cylindrical, capped with an apical cone. Mentum with seven to u teeth.

Pupa.— Cephalic crest lacking. Sheaths of maxillary palpi not recurved at tips. Pron breathing horns large, broadly flattened, margin deeply crenulated. Mesonotum with blunt tubercles. Abdominal segments with six to ten spines on tergites, three to five spi on sternites.

Tanyptera is a small genus including about twelve nominal spec whose limits and relationships are still but little understood. The imm ture stages are spent in the decayed or partly decayed wood of vario deciduous trees.

In Europe, *Tanyptera atrata* (Linn.), the genotype, was found by Per (1840) and by De Rossi (1882) in decaying alder (Alnus) stems. Nör linger (1848) found the same species in linden (Tilia) and in popl (Populus). It has also been taken in oak (Quercus), beech (Fagu birch (Betula), and other hardwood species. Gerbig (1913) discussed t variety *ruficornis* Meig. under the name *Ctenophora flavicornis*.

In America, Malloch (1915–17 b: 194–195) describes *T. fumipen* (O. S.) from a much-decayed chestnut log (Castanea), and later (191 in basswood (Tilia), where the species was associated with larvae *Xylota fraudulosa* Loew and *Chalcomyia aerea* (Loew), of the fam Syrphidae. *Tanyptera frontalis*, discussed below, was found in red ma (Acer).

Tanyptera frontalis (O. S.)

1864 *Ctenophora frontalis* O. S. Proc. Ent. Soc. Phila, vol. 3, p. 48.

ıe writer found numerous larvae of *Tanyptera frontalis* in a fallen of red maple (*Acer rubrum* Linn.) near Beebe Lake, Ithaca, New , on March 22, 1913. Larvae of several sizes were found. They working in wood which was well preserved, not entirely sound but so hard that it had to be cut with a hatchet. The larvae pupated pril. A small male emerged on May 1.

her larvae of Tanyptera were found in a hickory log (*Carya* sp.) andy Landing, Virginia (opposite Plummers Island), on September 13. Detailed drawings of the larval structure made by Dr. Böving n the collection of the United States National Museum.

a.— Length, 30–35 mm.
Diameter, 7–7.2 mm.

ration, pale yellowish white.

m terete, very stout. Integument thin. Numerous long black setae on segments LXXXVIII, 482), arranged in transverse rows before posterior margin; setae of n (Plate LXXXVIII, 481) very tiny, one on either side of median line; a pair of setae l of these and in alinement; setae on pleural region very long and delicate; on thoracic nts, setae at about midlength; on abdominal segments, setae closer to posterior n; mid-ventral setae very tiny, four in number, on thoracic segments at about mid-, forming a stiff pencil on sides of venter, with two small setae between; laterad of four intermediate setae, a group of three setae, two long and one very short; ventral setae at a level posterior to that of pleural setae. Spiracular disk (Plate LXXXVIII, with lobes practically lacking, the two large, oval spiracles lying exposed on trun- end of last segment; above and laterad of each spiracle, a small, blunt lobe with a ned mark and three long setae; below spiracles, two narrow black lines representing o ventral lobes; a small pencil of setae below each of these marks, and each mark a sensory bristle; three or four long setae on sides of spiracular disk. Spiracles with middle piece black, ring yellowish brown; spiracles separated by a distance a little r than diameter of one. Anal gills four, bluntly rounded, very protuberant and tly formed for propulsion. (In older specimens the anal gills are minutely roughened e darker in color.)

d capsule of the massive tipuline type. Labrum rather broad; median epipharyngeal with a small brush of hairs surrounding two sensory setae; lateral lobes large, on their l face densely hairy, surrounding four sensory setae and a flattened hyaline peg. ım (Plate LXXXVIII, 478) rather small, broadly rounded, anterior margin with or nine teeth, in the latter case the outermost tooth on either side very blunt and d, the median tooth long and flattened. Antenna (Plate LXXXVIII, 479) short- rical; apical papilla very small, hyaline, conical, with surface sculptured; in addition cone, three or four small hyaline sense pegs; the usual auditory organ located at midlength of segment. Mandible (Plate LXXXVIII, 480) small, with one dorsal and entral tooth in addition to the apical point, ventral tooth flattened and with margin ated; a stout seta at heel of mandible; prostheca an elongated cone, situated at base

of mandible. Maxilla rather small, simple; palpus large, antenniform, with apex blunt rounded; inner lobe densely covered with short, stout setae surrounding a powerful bris and a small brown sensory organ.

Pupa.— Length, 30–33 mm.
Width, d.-s., 5–6 mm.
Depth, d.-v., 5.5 mm.

Coloration pale yellow; pronotal breathing horns liver-colored. (In older specime the thorax and appendages are dark-colored, and the abdomen has broad brown sublate stripes.)

Head rather small, cephalic crest lacking. Antenna stout, rather elongate, extending l beyond ends o palpi, segments angulated. Clypeus and labrum tumid, transversely wrinkle Labial lobes slender, divergent. Sheaths of maxillary palpi rather slender, tips cur but not recurved (Plate LXXXVIII, 485). Pronotal breathing horn (Plate LXXXVI 486) large, broadly flattened, slightly incurved, broader at apex than at base, deeply furrow up middle of outer face, the broad margin thus formed deeply wrinkled to crenulat Mesonotum large, transversely wrinkled, with two blunt tubercles provided with short set (Plate LXXXVIII, 484). Wing sheaths small, reaching end of second abdominal segmen Leg sheaths ending before tip of third abdominal segment; fore tarsi very short, hi tarsi the longest, those of middle legs intermediate.

First abdominal tergite with two spines; segments 2 to 7 broad, divided into the usual bas and posterior rings; second segment on posterior ring with four spines; segments 3 to 6 wi six to ten spines, the intermediate ones usually smaller; segment 7 with four spines; pleurit with a spine on each ring; sternites with similar arrangement to that of tergites, but spin usually fewer in number, segments 3 and 4 with only a single widely separated spine on eac side, segments 5 and 6 with four or five spines, segment 7 with three spines; segment 8 h four small spines between the large lateral ones described below. Male cauda blunt, dors lobes very divergent, ending in sharp, chitinized points. Female cauda (Plate LXXXVI 487) with tergal valves elongate, narrowed to the moderately acute tips; sternal val similar in shape but smaller; lateral lobes of ninth segment directed caudad and latera at tips running out into chitinized points; two small setae before tips; segment 8 with powerful lateral lobe on either side, each terminating in a chitinized point; posterior la eral angles of segment produced into slender, blunt points.

Nepionotype.— Ithaca, New York, March 22, 1913.
Neanotype.— May 1, 1913. No. 11-1913.
Paratypes.— Four larvae and two pupae with types.

Subtribe **Tipularia**

Genus **Longurio** Loew (Lat. *a tall man*)

1869 *Longurio* Loew. Berl. Ent. Ztschr., vol. 13, p. 2.

Larva (supposition).— Body massive. Integument semi-transparent. Form clear depressed. Spiracular disk surrounded by six lobes, dorsal pair very small, ventral pa very long; ventral and lateral lobes provided with but few setae at and near tips; spiracul

and lobes unmarked. Spiracles small. Anal gills branched. Mandible small, with single dorsal and ventral tooth in addition to apical point. Mentum with nine teeth. pharynx five-toothed.

pa.— Antenna short, ending opposite tips of maxillary palpi. Sheaths of maxillary not recurved at tips. Mesonotum unarmed. Pronotal breathing horns very long and er, one, at least, about half length of body. Wings showing clearly the characteristic ion of Longurio. Abdomen elongate, posterior ring of individual segments with short, spines, including a few on pleurites; dorsum of eighth segment with four powerful lobes.

ongurio is a small genus including about ten described species, of h two occur in eastern North America. The genotype, *Longurio ceus*, is the best-known species locally. The immature stages of this ies are here discussed for the first time. They are spent in sand andy earth. The branched anal gills of the larva, and the excessively gate breathing horns of the pupa, are notable features.

urio testaceus Loew

869 *Longurio testaceus* Loew. Berl. Ent. Ztschr., vol. 13, p. 2.

ngurio testaceus is probably the largest crane-fly in North America, females exceeding the better-known Holorusia of the Western States. adult flies are difficult to capture, being very wary. When the insect rest the body generally hangs perpendicularly, with the wings folded mbent over the abdomen.

n November 9, 1916, Mr. Hyslop sent the writer two living larvae h are referred with little doubt to this species. They were found et sand in a bog on the top of South Mountains, near Myersville, yland. The larvae were very restless, the head capsule being con- tly exserted and withdrawn. Waves of contraction start from the erior end of the body and pass toward the head. A large pupa taken Dr. J. C. Bradley at Tallulah Falls, Georgia, on June 17, 1910, ubtedly belongs to this species, the venation being clearly apparent he wing pad. An additional cast pupal skin is in the collection ne United States National Museum.

va (supposition).— Length, 31 mm. contracted, 58 mm. extended.
Diameter, 11–12.5 mm.

or whitish, subhyaline; thoracic segments more yellowish; in life the brown food contents ng clearly thru abdomen.

m very depressed, lateral folds prominent; body very stout and fleshy. Skin very thin emitransparent, showing internal organs within, practically destitute of pubescence;

a few short setae on body, especially on thoracic segments. Spiracular disk (Plate LXXXI 490) large, flattened, surrounded by six lobes; dorsal pair very small, represented by two sho conical protuberances; lateral and ventral lobes slender, the latter a little the longer, ea with three or four long, delicate setae at tip and two or three others before tip on outer fa a long seta on margin of disk between dorsal and lateral lobes; spiracular disk and lob entirely unmarked with darker. Spiracles small, circular, stigmal rings very narrow; s acles separated by a distance equal to about three times diameter of one. Anal gills fo large, pinnately branched, each gill with six lateral branches.

Head capsule massive, of the tipuline type. Labrum with a distinct, densely hairy lo on either side. Mentum (Plate LXXXIX, 488) large; anterior margin with nine slend teeth, median one the longest, outermost teeth on either side blunt, flattened, eviden formed by fusion of two teeth. Hypopharynx (Plate LXXXIX, 489) five-toothed; to blunt, the three middle ones larger, the lateral tooth on either side a little smaller. Anten long and slender, cylindrical; apex blunt and without distinct sense pegs or setae. Mandi small, with a large conical dorsal tooth and a single flattened ventral tooth in additi to apical point; prostheca distinct. Maxilla small; palpi large, cylindrical, truncated apex and with a circular auditory plate near end; inner lobe of maxilla with abundant elo gate setae.

Pupa.— Length, 42–45 mm.
Length of longest breathing horn, 18–19 mm. additional.
Width, d.-s., 3 mm.
Depth, d.-v., 4.2 mm.

Color dark brown; pronotal breathing horns paler at tips; mesonotum chestnut brow abdominal segments indistinctly ringed with pale and darker.

Front between antennal bases swollen, finely tuberculate but without distinct seta Antenna very short, ending opposite tips of maxillary palpi. Labrum large. Sheaths maxillary palpi not recurved at tips. Mesonotum unarmed, with fine transverse wrinkl Pronotal breathing horns (Plate LXXXIX, 491) very long and slender, the right one, at lea exceedingly elongate, with tip expanded. (The left breathing horn was broken before t apex in both the pupae studied; it was almost as long as the right horn, and may, of cour have been longer.) Wing pads reaching end of second abdominal segment; characteris venation of genus showing clearly on sheath. Leg sheaths long, extending to beyond mi length of fourth abdominal segment; fore legs shorter than the others.

Abdomen elongate. Abdominal segments 2 to 7 near posterior margin with a transve row of short, stout spines which are interrupted only near pleura; pleural area with fe or five spines; ventral and dorsal segments with numerous spines; dorsal row of spines m distant from posterior margin of segment than the other areas; dorsum of eighth segme with four powerful, chitinized lobes directed dorsad and caudad; posterior margin of th lobes with about five or six small teeth; two spines near base of pleural region on segment Male cauda consisting of two blunt sheaths, lying between posterior pair of lobes describ above.

Larva.— South Mountains, near Myersville, Maryland, November 6, 1916.
Neanotype.— Tallulah Falls, Georgia, June 17, 1910.
Paratype.— Cabin John Bridge, Maryland, May 31, 1900.

us **Aeshnasoma** Johnson (Gr. *a dragon fly + body*)

909 *Aeshnasoma* Johns. Proc. Bost. Soc. Nat. Hist., vol. 34, p. 115–116.

eshnasoma is a monotypic genus found in northeastern North America. unquestionably close to Longurio and may be congenerous with it. type, *Aeshnasoma rivertonensis* Johns., is apparently very local in istribution.

hnson (1906:1–2) described an unknown tipuline larva which undoubt- pertains to this species. The larva was found on June 10, 1900, cold spring at Riverton, New Jersey. It was brought into the labora- but could not be reared, the change from the cold spring (about F.) to warmer waters being fatal. The larva when fully extended sured about 45 millimeters in length. It was yellowish white in and was translucent, the alimentary canal with its contents being ly visible thru the thin skin. Johnson describes and figures the liar branched anal gills (Plate LXXXIX, 492) of this genus. The was doubtfully referred to Longurio, the adults of Aeshnasoma undescribed at that time.

a later paper (1907–12 [1909]:115–116) Johnson mentions the taking veral more larvae in 1902, and, on July 20, the capture of the adult flies hich the genus and species are based.

he only larva that was preserved was kindly sent to the writer for y by Mr. Johnson. It is undoubtedly very close to Longurio, both ra showing the same peculiar spiracular disk and the branched anal a condition that is found nowhere else in the Tipulidae so far as is vn to the writer.

us **Holorusia** Loew (derivation obscure)

863 *Holorusia* Loew. Berl. Ent. Ztschr., vol. 7, p. 1.

va. — Spiracular disk surrounded by six moderately elongate lobes fringed with long inner face of lateral and ventral lobes with capillary black lines; disk between spiracles . Anal gills six. Mandible small, with a single dorsal and ventral tooth in addition cal point. Antenna with a conical apical papilla. Mentum seven-toothed. Hypo- nx six-toothed.

pa. — Sheaths of maxillary palpi recurved at tips. Pronotal breathing horns rather and stout, the long apices flattened. Armature of abdominal segments almost as in ocera, but the posterior rows of spines more numerous (fourteen to twenty-four); es with three spines, the two on posterior ring situated one behind the other. Cauda ix stout dorsal lobes.

Holorusia is a small genus (about ten species) of New World cran flies, only one of which—the genotype, *Holorusia rubiginosa* — is Nearct This species and Longurio are the largest Nearctic crane-flies. T anatomy of the "giant crane-fly" has been described in some det by Kellogg (1901, a and b) and by Comstock and Kellogg (1904). T immature stages are spent in moist earth. The genus is undoubted closely related to Prionocera, and, presumably, to the Old World gen Ctenacroscelis Enderlein.

Holorusia rubiginosa Loew

1863 *Holorusia rubiginosa* Loew. Berl. Ent. Ztschr., vol. 7, p. 1.
1888 *Tipula* (*Holorusia*) *grandis* Bergr. Ent. Tidskr., vol. 9, p. 140.

Holorusia rubiginosa is widely distributed thruout the western Unit States and Canada. A number of larvae were taken by H. Morris near Stanford University, California, on February 22, 1915. They we shipped to the writer at Ithaca, New York, where the species was reare The massive larva is used for purposes of dissection in the entomologic courses at some of the western universities.

Larva.— Length, 50–60 mm.
Diameter, 6.2–6.4 mm.

Coloration, dark greenish brown.

Form stout, subterete. Integument covered with dense, short, erect, black hairs. few weak and delicate setae, two on dorsum and on venter of each abdominal segment; t long setae on lateral margins of posterior rings. Spiracular disk (Plate XC, 496) moderat large, surrounded by six stout, elongate lobes which are similar to those of Prionocera b are stouter and less digitiform; ventral lobes a little the longest, dorsal lobes a little the sho est; all the lobes capable of close approximation, completely protecting spiracles; lob fringed with long black hairs which are longest near apices, shorter between lobes; vent and lateral lobes with a delicate black line down inner face, these lines barely indicat on dorsal lobes; remainder of disk and lobes dusky. Spiracles very large, circular, separat by a distance a little less than diameter of one. Anal gills six, short, slender, the t anterior gills of either side united basally, posterior pair simple.

Head capsule of the usual massive tipuline type, prefrons running caudad as a narr point, lateral plates broad. Labrum broad, with a densely hairy lobe on either side. Me tum (Plate XC, 493) with a prominent median point; behind it on either side three flatten teeth, the innermost the broadest, the middle tooth more acute, the outermost formed fusion of two small teeth. Hypopharynx (Plate XC, 494) about six-toothed, the intermedi teeth with a large notch between. Antenna (Plate XC, 495) with basal segment very lo and slender; principal apical papilla conical; a number of small hyaline sense pegs. Man

nder, with only two teeth, a stout dorsal tooth and a single flattened ventral tooth. a small, lobes covered with short, dense hairs.

a.— Length, 32 mm.
Width, d.-s., 5 mm.
Depth, d.-v., 5 mm.

r brown; flattened lateral margins of abdomen broadly yellowish.

rax terete; abdomen depressed, with lateral margins flattened, carinate. Cephalic epresented by two low, parallel ridges, provided with one or two tiny setae. Labrum tumid, transversely wrinkled, the blunt apex completely separating the diamond- l labial lobes. Maxillary palpi stout, extreme tip recurved. Antenna moderately ted, extending some distance beyond maxillary palpi. Pronotal breathing horns rather nd stout, finely ringed, the rather long tips flattened, about equal to one-fifth length ire organ. Mesonotum convex (Plate XC, 497), with transverse anastomosing es; on either side of median line behind, a blunt tubercle. Wing sheaths reaching end nd abdominal segment. Leg sheaths extending just beyond base of fourth abdom- gment; fore tarsi short, middle tarsi a little longer than hind tarsi.

ominal segments with the usual basal and posterior rings; armature almost as in cera; tergites with posterior row of spines numbering between twenty and twenty- n intermediate segments, near anterior lateral angle two spines, basal ring unarmed; es with one setiferous spine on basal ring and two similar spines on posterior ring, ced considerably behind the other; sternites armed similarly to tergites, but the poste- w of spines larger and somewhat fewer in number (fourteen to eighteen); posterior ring ier side median line near base with two spines, the innermost very large and power- Male cauda with ventral lobes blunt, each armed with a slender black spine near pos- margin; dorsal surface of cauda almost as in Prionocera, armed with six stout lobes, here are shorter and stouter, with tips abruptly narrowed; lateral margin of segment a stout lobe on either side, each terminating in a cylindrical spine. Female cauda to male cauda, dorsum with the same six lobes; acidothecae short, tergal valves exceeding the more blunt sternal valves.

ionotype.— Stanford University, California, February 27, 1915.
notype.— April 5, 1915.
types.— Larvae and pupae with types.

s **Prionocera** Loew (Gr. *saw* + *horn*)

44 *Prionocera* Loew. Stett. Ent. Zeit., vol. 5, p. 170.
63 *Stygeropis* Loew. Berl. Ent. Ztschr., vol. 7, p. 298.

a.— Spiracular disk surrounded by six long, finger-like lobes fringed with long, deli- irs; each lobe with a capillary black line down middle of inner face. Spiracles large. gills unbranched. Mentum seven- to nine-toothed. Hypopharynx five-toothed. ble with about two dorsal and three ventral teeth.

a.— Maxillary palpi recurved at tips. Pronotal breathing horns very elongated, l, the longer one about half length of body; horns at tips split into long flaps. Abdom- rgites with a posterior transverse row of fifteen or fewer spines, and two small spines

near anterior lateral margin of posterior ring; pleurites with a spine on basal ring and transverse spines on posterior ring. Cauda with six strong dorsal lobes.

Prionocera is a small genus (about a dozen species) of usually far north flies of somber coloration. The only species found in eastern No America is *Prionocera fuscipennis*, discussed below. The imma stages are somewhat similar to those of Holorusia. The apparent simila of the pupa to that of Longurio is probably not indicative of a very c relationship.

The immature stages have been discussed but little in the literat The "Tipula sp. No. 1" of Malloch (1915–17b:199–200) refers to *P. fu pennis*. The immature stages of a species supposed to be *P. parri* (Kir have been discussed and figured by the writer in his report on the Canadi Arctic Tipulidae (Alexander, 1919c:19c–20c).

The name *Stygeropis* has been in use for many years under the be that the earlier name *Prionocera* was preoccupied in the Coleopt Dr. Bergroth states that this is not so and that Prionocera should used.

Prionocera fuscipennis (Loew)

1865 *Stygeropis fuscipennis* Loew. Berl. Ent. Ztschr., vol. 9, p. 129.

C. H. Kennedy found two cast pupal skins among Sparganium ste in Ringwood Hollow, Ithaca, New York, on November 20, 1916. Seve larvae had been found here in the preceding July, and some others w found on June 4, 1917 (No. 106–1917), in a cat-tail swamp near Bo hillside, Ithaca, where they were associated with the characteristic h phytic crane-fly fauna (Bittacomorpha, *Rhamphidia flavipes*, *Pseudol nophila luteipennis*, *Pilaria recondita*, *Tipula tricolor*, and other speci Malloch's material was taken in Wisconsin in May. Dr. Needham reared the species near Lake Forest, Illinois.

Larva.— Length, 18–22 mm.
Diameter, 2–2.2 mm.

Coloration dark brown, in some cases with a pale dorso-median stripe.

Form terete, tapering gradually to anterior end of body. Segments with several scatt elongate setae. Spiracular disk (Plate XCI, 502) surrounded by six long, finger-like l which are delicately fringed with long hairs; ventral lobes considerably the longest; la lobes a little larger and stouter than dorsal lobes; all the lobes broadly margined with brown, these marks expanding at inner ends; on ventral lobes, lateral margin expanded at i

nd continued across disk, meeting its fellow of the opposite side between spiracles; margin of lateral lobes touching spiracles; each of the lobes marked with a capillary rown line down center of inner face, this beginning near ends of lobes and extending to base; lobes fringed with long hairs, these very tiny near base, longer near tips of but scarcely, if at all, interrupted between lobes. Spiracles large, circular, separated by a distance a little greater than diameter of one. Anal gills six, long, slender, nched.

d capsule of the usual tipuline type. Labrum covered with dense, short hairs, those eral lobes longer. Mentum (Plate XCI, 498) usually seven-toothed, in some cases nine-d; median tooth slender, lateral teeth flattened, subacute. Hypopharynx (Plate 499) narrow, five-toothed. Antenna (Plate XCI, 500) long and slender; first segment enlarged near base; at apex several tiny sensory papillae; auditory plate near base ment. Mandible (Plate XCI, 501) moderately large, with two large dorsal and about ventral teeth; prostheca large. Maxilla small; palpus large, cylindrical, apex truncated.

a.— Length, 15–22 mm.
Width, d.-s., 2.4 mm.
Depth, d.-v., 2.6 mm.

ration dark brown; lateral and posterior margins of abdominal segments paler. (In ecimens the general coloration is very dark brown; in younger specimens the abdomen e or less distinctly lined with brown.)

rax subterete; abdomen depressed, lateral margins flattened. Labrum broad, apical narrow. Labial lobes broad, slightly separated on median line. Maxillary palpi stout, apex recurved. Antenna moderately elongated, extreme tip darkened. Pro-breathing horns long and slender, unequal in length, the longer about 9 or 10 mm. th, the other 6 mm., at tips split into divergent flaps (Plate XCI, 504) almost as in xatomine genera Pseudolimnophila and Pilaria, which live in the same muddy sit-s. Mesonotum (Plate XCI, 503) transversely wrinkled. Leg sheaths reaching posterior of third abdominal segment; hind legs the longest; middle legs a little shorter than gs.

ominal segments divided into a basal and a posterior ring; tergites with basal ring ed; posterior ring with a subterminal transverse row of short spines, with a few setae on lateral face of some of the spines; on second tergite, four to six spines, on ter- to 7, three to fifteen spines; two small spines with setae near anterior lateral angle erior ring; pleurites with a small setiferous spine on basal ring, and two such spines terior ring located side by side; sternites with the basal ring unarmed, posterior ring similarly to that of tergites; in addition to posterior row of spines, a pale oval area er side of midventral line, each with two transversely placed spines. Male cauda XCI, 505) with four powerful lobes on dorsum of last segment, directed dorsad and caudad, lobes bearing three or four small spines before tips; between anterior pair s, two additional slender lobes, each ending in two acute spines.

onotype.— Ringwood Hollow, Ithaca, New York, July 20, 1916.
notype.— Cast pupal skin, type locality, November 20, 1916.
types.— Larvae and pupal skins, type locality.

Genus **Tipula** Linnaeus (Lat. *a water-strider*)

1758 *Tipula* Linn. Syst. Natur., ed. 10, p. 585.
1842 *Pterelachisus* Rond. Mag. Zool. Ins., pl. 106.
1864 *Anomaloptera* Lioy. Atti dell' Institut Veneto, ser. 3, vol. 9, p. 218.
1887 *Oreomyza* Pokorny. Wien. Ent. Ztg., vol. 6, p. 50.
1894 *Manapsis* Scudder. Proc. Amer. Philos. Soc., vol. 32, p. 222.
1894 *Rhadinobrochus* Scudder. Proc. Amer. Philos. Soc., vol. 32, p. 223.
1894 *Tipulidea* Scudder. Proc. Amer. Philos. Soc., vol. 32, p. 238–239.
1916 *Nippotipula* Mats. Thous. Ins. Japan, add. 2, p. 457–458.
1916 *Platytipula* Mats. Thous. Ins. Japan, add. 2, p. 459.
1916 *Yamatotipula* Mats. Thous. Ins. Japan, add. 2, p. 461–462.
1916 *Togotipula* Mats. Thous. Ins. Japan, add. 2, p. 465.

Larva.— Form generally stout, terete or nearly so. Integument with pubescence s almost invariably with a definite chaetotaxy. Spiracular disk surrounded by six or ra eight lobes, simple, or in certain species (as *T. abdominalis*) more or less split at their t Spiracles small and widely separated (in *T. abdominalis*), or in other species large and ra close together. Anal gills almost invariably present, with six or eight branches, ti branches simple, not pinnate. Head capsule compact and massive. Labrum broadly tra verse. Mandible usually small, with few teeth, ventral cutting edge with usually two three teeth. Maxilla rather complicated, of the generalized tipuline structure. Ante usually elongated, basal segment two to four times as long as it is thick, stouter in spe living in decaying wood. Mentum with seven to nine teeth. Hypopharynx a flatte plate, anterior margin usually with five teeth.

Pupa.— Form generally stout. Cephalic crest lacking or very small, with rudiment setae. Mouth parts as in the subfamily, sheaths of maxillary palpi strongly recur at tips. Pronotal breathing horns subequal in length, short, stout, usually straight, t but little expanded. Mesonotum transversely wrinkled, in some wood-inhabiting spe (as *T. trivittata*) with about four conspicuous tubercles. Wing sheaths and leg shea moderate in length. Abdominal armature usually strong, each segment with a poste row of four to twenty spines; in some species a basal ventral row of spines on posterior r of segments. Cauda with dorsal armature of four powerful lobes; eighth segment addi as a rule, ten spines, of which six are ventral and lateral in position, and two or four are dor dorso-median pair lying between anterior pair of lobes of cauda, as discussed above, a lacking or very reduced in some wood-inhabiting species (*T. trivittata*). Lateral abdomi spiracles lacking or merely vestigial.

Tipula is the largest genus of crane-flies, comprising a vast assembla of species (between six and seven hundred described forms) which a found on all the continental areas of the world but are few in the Austr asian region and apparently lacking on many of the lesser oceanic islan The genus is one of extreme interest, and its study will require ma years of conscientious application. Subapterous species are not rare this group, of which many are far northern forms, others are coastal sp cies, while a few live inland and under influences that make it difficult explain their subapterous condition.

The immature stages of the various species are diverse in their habits, ging from species that are nearly if not quite aquatic, thru the majority he known forms which live in generally moist earth or mud along the rgins of water bodies, to still others that live in the semi-decayed d of prostrate tree trunks. Mellor (1919:64) has recorded Tipula ae as breeding in manure. So far as is known, the larvae are herbiv- is, tho they will eat animal food under stress (as described by Patter- [1908] for *Tipula oleracea*, which feeds in considerable numbers on hworms).

n Europe, a great number of life histories in this genus have been ked out in commendable detail, mainly thru the efforts of Beling, discusses no fewer than thirty species. His descriptions give a clear of the range in structure and habitat to be expected in the genus. number of lobes surrounding the spiracular disk varies from four parently) in *T. selene* and related forms, to as many as eight in *T. nodicornis*. Practically all of the known species show the normal line number of lobes, six.

summary of the larval habitats of the Palaearctic species is as follows:

Species living in saturated earth along watercourses or in débris at the water's edge, ecies that are aquatic — *Tipula fulvipennis* de Geer, *lateralis* Meig., *lunata* Linn., *maxima* , *variicornis* Schum., *variipennis* Meig., *vittata* Meig.

Species living in earth, usually in woods, underneath a mold of leaves or coniferous les — *Tipula caesia* Schum., *dilatata* Schum., *fulvipennis* de Geer, *hortensis* Meig., *lana* Meig., *nigra* Linn., *nubeculosa* Meig., *ochracea* Meig., *pabulina* Meig., *paludosa* ., *pruinosa* Wied., *scripta* Meig., *selene* Meig., *truncorum* Meig., *unca* Wied., *variipennis* ., *vittata* Meig.

Species living in earth in gardens, pastures, or meadows, usually beneath turf — *Tipula ata* Macq., *luteipennis* Meig., *nigra* Linn., *ochracea* Meig., *oleracea* Linn., *paludosa* Meig., *nosa* Wied., *subnodicornis* Zett., *truncorum* Meig., *vernalis* Meig.

Species living in or beneath cushions of moss or in earth overgrown with a mossy ring — *Tipula dilatata* Schum., *hortulana* Meig., *marmorata* Meig., *pagana* Meig., *stigma* Schum., *pruinosa* Wied., *rufina* Meig., *signata* Staeg., *truncorum* Meig., *unca* .

Species living underneath moss on logs — *Tipula irrorata* Macq.

Species living in decaying wood — *Tipula flavolineata* Meig., *irrorata* Macq., *truncorum* .

ouché describes *T. lunata* and *T. ochracea* as living in decaying willow d, and Sopotzko records *T. flavolineata* as injuring clover; but these rds are presumably based on mistaken identifications.

omparatively few of the eastern American species have been reared, it is not considered advisable to attempt a key to the larvae or the ae at this stage of knowledge of the subject. Such a key would

include but a fraction of the possible species and would be of little val
It will require the careful rearing of species for many years before
workable key to the immature stages of the eastern species of the ge
can be produced. The characters that will prove of greatest value
the separation of the larvae and the pupae of the species of Tipula are
follows:

Larvae

1. *Anal gills.* (These are rarely lacking, and the number and arrangement of the branch
their form, and their function, are of primary importance.)
2. *Spiracular disk.* Number of lobes surrounding disk and whether they are simple
branched; character and nature of fringe of hairs around disk, if such is present; size, sh
and distance apart of spiracles; markings on inner face of disk and lobes.
3. *Chaetotaxy.* Arrangement, length, and number of setae on segments.
4. *Body form.* Terete, subdepressed, or flattened ventrally only; clothing of pubesce
and pattern formed on dorsum.
5. *Head capsule.* (The head is remarkably uniform thruout the group, a condition
be expected in a group so compact as Tipula.) Shape of mentum and hypopharynx,
number, size, and shape of teeth along their anterior margins; shape of antenna, and ot
details of head.

Pupae

1. General form, whether terete or depressed.
2. Mouth parts.
3. Pronotal breathing horns, their relative length, size, and form.
4. Armature of mesonotum.
5. Wing sheaths and leg sheaths.
6. Spines on abdominal segments, their size and number; whether lacking or present
base of posterior ring of sternites; arrangement and number of pleural spines.
7. Cauda, shape of genital sheaths, armature of dorsum, and ventral margin of eig
sternite.

Descriptions are given in the following pages of about ten life histori
which are entirely new or have been insufficiently considered elsewhe
A few notes on certain other species that have been observed in the p
few years may be added here:

Tipula cayuga Alex. A conspicuous yellow larva, living in organic earth beneath leav
in association with *Bittacomorphella jonesi* and other forms which are discussed elsewh
(page 781). The pupal duration is slightly over seven days.

T. angustipennis Loew. Found living in rather dry earth beneath leaves in shaded woo
(Lawrence, Kansas, Mrs. C. P. Alexander).

T. umbrosa Loew. Occurs in garden soil in company with the larvae of *Tipula bicor*
Forbes.

T. fuliginosa Say. Reared from larvae living in débris under the nest of a turkey vult
(Jackson Island, Maryland, May 23, 1913, R. C. Shannon).

T. sayi Alex. and *T. tricolor* Fabr. In saturated mud in marshy or swampy situatio

T. tephrocephala Loew. A large larva, nearly if not quite aquatic in its habits.

e life histories of other Nearctic species are recorded in the sum- of literature on page 980. These are as follows: *Tipula arctica* (Nielsen, Alexander), *T. eluta* Loew (Hart, Malloch), *T. cunctans* Hyslop, Malloch), *T. bicornis* Forbes (Forbes), and *T. ultima* Alex. dham, Caudell). *T. arctica*, according to Nielsen (1910:57–59), was d commonly in eastern Greenland. The immature stages were dis- ed in circular holes from two to three centimeters deep in the ground, ially beneath tufts of *Cassiope tetragona* (L.) D. Don. The pupae found at the end of June, and empty pupa cases were found as early e 25th of the same month. According to Nielsen, the larvae require ears to attain their growth.

la (*Trichotipula*) *oropezoides* Johns.

09 *Tipula oropezoides* Johns. Proc. Boston Soc. Nat. Hist., vol. 34, p. 131–132.

rvae of *Tipula oropezoides* were first found on March 30, 1917, living th saturated moss in Needham's Glen, Ithaca, New York, where were associated with larvae of *Dicranomyia badia*, *Penthoptera rsis*, *Tipula collaris*, and other species. Numerous additional larvae found in the same locality on April 18, 1917. Some of these were d in rearing and emerged on May 6. The larvae are nocturnal in habits, being very sluggish and retiring during the day but becoming e after sunset.

e adult flies bear a strong resemblance to species of the genus Oropeza, which they are sometimes found associated. They may often be from rank herbage in cool Canadian woods.

.— Length, 16.5–17 mm.
Diameter, 1.8–2 mm.

ation above, a deep velvety brown with mottlings of paler; on basal ring of tergites lian transverse pale spots, posterior ring less regularly marked; pleura and venter (The dark markings on the dorsum are produced by patches of dark-colored hairs, over the body densely in places.)

subterete. Integument with an abundant pubescence, longest on dorsum. Chaeto- follows: dorsum (Plate XCIII, 516) on posterior ring with six stout setae, three on ide, the middle seta a little closer to the inner seta; ventral segments (Plate XCIII, th four setae, two anterior and two posterior, the latter a little more separated. lar disk (Plate XCIII, 518) surrounded by six approximately subequal lobes, their ces heavily lined with dark brown; at tip of each lobe a pale rounded spot, largest on lobes and here with a sensory bristle; lateral mark not reaching spiracles; lateral sal lobes slightly paler medially; above and below each spiracle a transverse brown

line; on disk, between spiracles, two indistinct dusky spots; lobes fringed with rather shor pale hairs which are narrowly interrupted between lobes. Spiracles irregular, roughl triangular. Anal gills four, slender, posterior pair the larger (Plate XCII, 506).

Head capsule as in genus. Labrum and maxilla very densely fringed with long golde yellow hairs. Mentum (Plate XCIII, 513) with two flattened lateral teeth, the media point elongated; mentum very deeply split behind. Hypopharynx (Plate XCIII, 514) wi but three evident teeth, the lateral teeth very broad, flattened. (In some specimens the teeth are all very blunt, so that the anterior margin of the hypopharynx appears merel crenulate.) Antenna with apical disk very flattened. Mandible (Plate XCIII, 515) wi a dorsal tooth and a powerful ventral tooth.

Pupa.— Length: male, 12 mm.; female, 12.5–13 mm.
Width, d.-s.: male, 1.6–1.7 mm.; female, 1.8–1.9 mm.
Depth, d.-v.: male, 1.6 mm.; female, 1.7–1.8 mm.

Coloration dark brown; dorsum of thorax and abdomen, and face, more reddish brow

General features as in *Tipula collaris*. Form slender. Pronotal breathing horns lon and slender, dark-colored, divergent at tips. Antenna elongate. Wing sheaths endin opposite apex of second abdominal segment. Leg sheaths long, extending to beyond mi length of fourth abdominal segment. Male cauda with dorsal lobes of genitalia short, blun ventral lobes produced caudad into slender, blunt lobes which are transversely wrinkle separated by a U-shaped notch, at base on outside with a prominent spine. Female ov positor elongate; dorsal valves narrowed to the blunt tip; ventral lobes stout, a little short than dorsal valves, tips strongly divergent; the six dorsal lobes of cauda spinous-tippe sharply pointed.

Nepionotype.— Ithaca, New York, April 18, 1917. No. 6–1917.
Neanotype.— With type. No. 7–1917.
Paratypes.— Numerous larvae and pupae.

Tipula collaris Say

1823 *Tipula collaris* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 23.

Larvae and pupae of *Tipula collaris*, a common vernal crane-fly occurred frequently beneath saturated moss (*Amblystegium irriguu* [Wils.] B. & S.) in Needham's Glen, Ithaca, New York, on April 17 1917. Their associates are noted under the account of *T. oropezoide* (page 1001). In the same moss areas occurred numerous small red-backe salamanders (*Plethedon cinereus*), which probably fed on the insect deni zens of the place. Specimens emerged in the writer's breeding jars as lat as May 10.

The adults are on the wing during April and May, some persisting int early June in cool northern woods. The life history undoubtedly require a year for its completion.

Larva.— Length, 21.5–25 mm.
Diameter, 2.5–3.5 mm.

Coloration pale dusky, darker above; dorsum behind with two broken lines which are ergent on each annulus, those of anterior annulus made up of three circular spots: pleura h a conspicuous dark brown stripe; venter almost uniformly pale, with indistinct lines; erior part of thoracic segments darker. (In life the color is rich reddish brown, and the ural stripe is not evident.)

Form terete. Body covered with a delicate, pale pubescence, in addition to the usual ae. Chaetotaxy as follows: tergites (Plate XCIV, 521) with a transverse row of six setae posterior ring before margin, the two innermost solitary, each lateral pair closely proximated; a solitary seta on extreme lateral margins of tergite, at margin of dark pleural pe, and at about midlength of posterior ring; pleura on basal ring with a single seta, pos- or ring with a group of about three or four setae, one larger than the others; sternites h four widely separated setae on posterior ring, the lateral pair a little nearer posterior rgin than the median pair. Spiracular disk (Plate XCIV, 522) surrounded by six lobes ch are moderately slender; ventral pair a little longer, dorsal pair a little shorter; all the es broadly margined with pale brown; ventral lobes having in addition a black capillary extending from tips backward to beyond midlength of lobes, this line broadest at tip, dually narrowing, and becoming paler toward base of lobes; below each spiracle, two spicuous black dots; lobes fringed with numerous rather long hairs. Spiracles large, arated by a distance a little greater than diameter of one. Anal gills six, one pair much rter than the others, consisting of a basal branch of the anterior gill.

Head capsule rather small, of the usual tipuline type. Mentum (Plate XCIV, 519) very ad, anterior margin almost transverse, seven-toothed, median point the longest. Hypo- rynx (Plate XCIV, 520) with five teeth, which are very short and blunt giving anterior gin a deeply crenulated appearance; before hypopharynx a rounded lobe which is densely ered with six short, blunt, chitinized points, this being probably the prementum. Antenna gate-cylindrical; apex with apical disk very small, button-like. Mandible small, with ut one dorsal and two ventral teeth. Maxilla slender, densely hairy; palpus subglobular, several small, hyaline papillae.

Pupa.— Length, 17–19 mm.
Width, d.-s., 2.8–3.2 mm.
Depth, d.-v., 3–3.3 mm.

oloration brown; wing sheaths, except in older individuals, pale; pleural region of abdomen yellow; abdominal incisures often pale.

ead rather small. Cephalic crest low and indistinct, with tiny setae. Labrum broad, pointed. Labial lobes oval, contiguous at inner end. Maxillary palpi strongly recurved ips. Antenna slender, moderately elongated, extending some distance beyond wing Pronotal breathing horns equal in length, rather short, the moderately long tips flat- d, smooth; two small, approximated setae on either side of median line. Wing sheath te XCIV, 523) extending just beyond end of second abdominal segment; venation dis- . Leg sheaths extending beyond base of fourth abdominal segment; fore tarsi con- ably shorter than the others.

bdominal segments with armature of posterior ring weak, the spines very short and stout, a few setae; maximum number of spines on the tergites about twenty; lateral anterior e of posterior ring of tergites with two small spines; pleurites with one basal spine, and

three setiferous spines on posterior ring, arranged transversely; spiracles very rudimentary opposite base of posterior ring; sternites with spines slightly more numerous and stouter near base of posterior ring two transverse spines on either side median line, the outermost setiferous. Male cauda on dorsum with six lobes; the four posterior ones stout, with tips spinous or those of ventral pair slightly bifid; the two anterior median lobes shorter and more slender; eighth sternite with four large spines about equally spaced; eighth pleurite with a large, powerful, acutely tipped lobe, and two or three smaller dorso-lateral spines above base of middle pair of dorsal lobes. Female cauda almost the same as male cauda due to the blunt terebral sheaths of this species.

Nepionotype.— Ithaca, New York, March 30, 1917.
Neanotype.— With type larva.
Paratypes.— Numerous larvae and pupae, March 30 to April 18, 1917.

Tipula nobilis (Loew)

1864 *Pachyrrhina nobilis* Loew. Berl. Ent. Ztschr., vol. 8, p. 62.

Larvae of *Tipula nobilis* were found in wet moss and beneath decaying witch-hazel leaves at Orono, Maine, on June 17, 1913. An adult emerged on July 1. A fully grown pupa found on July 11 attempted to transform but died after two hours without being able to extricate itself from the pupal case.

The adults, which strikingly resemble some species of Nephrotoma, fly somewhat later than does *T. collaris*, but both species may be taken together in early June.

T. nobilis is very similar in all respects to *T. collaris*.

Larva.— Length, 20 mm.
Diameter, 2.9–3 mm.

Coloration, reddish brown.

Spiracular disk as in *T. collaris*, the brown lateral margin to the lobes a little paler. Anal gills as shown in Plate XCII, 507.

Head capsule almost as in *T. collaris*. Mentum with apical point elongate, with three blunt teeth on either side. Hypopharynx with five moderately acute teeth. Antenna with a blunt conical papilla, larger and more conspicuous than in *T collaris*. Mandible with teeth very blunt.

Pupa.— Length of cast pupal skin, about 18.5 mm.

Pupa very similar to that of *T. collaris*.

Nepionotype.— Orono, Maine, June 19, 1913. No. 40-1913.
Neanotype.— With type.

Tipula bella Loew

1863 *Tipula bella* Loew. Berl. Ent. Ztschr., vol. 7, p. 291–292.

Tipula bella is a common species, flying thruout the summer. Larvae nd pupae are not rare in sandy or loamy soil along streams. A larva aken on April 28, 1917, in gravel at Ithaca, New York, where it was ssociated with larvae of Hexatoma, was placed in rearing. It emerged s an adult male on May 15. On May 27, 1913, three fully colored pupae ere found along the sandy banks of Fall Creek, Ithaca, in association ith *Eriocera spinosa*. They emerged as females on May 29 and 30.

Larva.— (The description is from field notes on the larva mentioned above.) Length, 20–25 mm.

Coloration light grayish brown, with a slight reddish cast most noticeable on venter; rsum with two narrow, almost continuous, dark brown lines, these lines subparallel at terior part of each segment, then strongly bellied out, and then parallel but finally vergent.

Spiracular disk surrounded by six rather short lobes; ventral lobes with a linear, rather le, brown mark, and a few sensory bristles at tips; lateral lobes with ventral margin lined th brown; dorsal lobes with both margins feebly bordered with brown; two small brown ts below each spiracle. Anal gills six, very long and slender.

Pupa.— Length of cast pupal skin, about 24 mm.

Pupa similar to pupae of other species of genus. Pronotal breathing horns short, lindrical, narrowed to tips. Spines on abdominal segments rather large, especially on rnites; spines on base of posterior ring of sternites small but evident. Female cauda th dorsal valves long, pointed; sternal valves shorter. Cauda with the usual six lobes dorsum, the four posterior stout, divergent, spinous-tipped, the anterior median pair ch smaller; venter of segment 8 with three strong spines on either side, gradually smaller m lateral spine toward innermost spine.

Neanotype.— Ithaca, New York, reared May 25, 1917.
Paratypes.— Pupal skins, type locality, May 5, 1914 (No. 42–1914); August, 1911; May 1917; etc.

pula caloptera Loew

1863 *Tipula caloptera* Loew. Berl. Ent. Ztschr., vol. 7, p. 292.

The vigorous larva of *Tipula caloptera* is one of the largest and most riking in the family. The larvae live in rapid- or slow-flowing streams her in the water among débris and under stones, or in the sand, gravel, mud in very close proximity to the water. Here they are associated th the larvae of various species of Eriocera, *Erioptera armata*, Tabanus, herix, and other forms. Oftentimes they are found in deep water in ceedingly lotic situations. A larva placed in rearing on April 19, 1917, erged as an adult female on May 13

This is evidently the larva taken by Dr. Needham in the Adirondacks and referred by him with some doubt (Needham and Betten, 1901:575-576) to *T. abdominalis*. This dubious reference has created considerable confusion ever since the species was figured on the cover of *Entomological News* under the facetious name "*Quisnam sexcaudatus?*" Malloch (1915-17b:200-201) mentions the same larva under the name *T. abdominalis*. As stated elsewhere, the larva of *abdominalis* is very different.

Larva.— Length, 45–55 mm.
Diameter, 4.8–6.8 mm.

Coloration above, dark brown or brownish green; segments beautifully marked with small white spots, especially anterior segments; a broad, dark brown, median stripe, and a more or less distinct pale lateral stripe (in preserved specimens the pleura is usually dark brown, more distinct behind, with numerous pale white dots); sternum dark greenish. (In older specimens the color is very dark and the pattern is more or less obliterated.)

Form stout, terete. Body smooth, segments with indistinct posterior tubercles. Chaetotaxy very weak, a few weak pleural setae on posterior ring, sternal and tergal setae minute. Spiracular disk rather small, surrounded by six subequal, moderately narrow, lobes which are fringed with short hairs; margins of disk and lobes somewhat as in *T. bella*, each lobe with a delicate capillary brown line; two brown spots beneath each spiracle. Spiracles small, separated by a distance about equal to twice diameter of one. Anal gills six, very long and slender (Plate XCII, 508).

Head capsule as in genus. Mentum broad; anterior margin nearly transverse, with three subacute teeth on either side, median point not conspicuously elongated.

Pupa.— Length of cast skin, about 32–35 mm.

Characters almost as in *T. bella*. Pronotal breathing horns short, cylindrical, tips not expanded. Abdominal spines prominent, projecting, few in number, on intermediate tergites 9 or 10; pleurites with a single strong spine on each ring; sternites with a posterior row of seven or eight strong spines; on segments 5 to 7 two strong spines at base of posterior ring, those of seventh segment the largest. Cauda almost as in *T. bella*.

Nepionotype.— Ithaca, New York, April 26, 1917. No. 16-1917.
Neanotype.— Cast pupal skin, reared May 13, 1917.
Paratypes.— Larvae and cast pupal skins from type locality.

Tipula dejecta Walk.

1856 *Tipula dejecta* Walk. Ins. Saunders, vol. 1, Dipt., p. 442.
1901 *Tipula fumosa* Doane. Journ. N. Y. Ent. Soc., vol. 9, p. 99.

Tipula dejecta is a characteristic vernal species flying in April and May. The flies are notable inhabitants of swamps, especially alder swamps.

On April 20, 1917, the writer found larvae of this fly in Larch Meadows near Ithaca, New York, in association with larvae of *Rhamphidia mainensis*, *Pseudolimnophila luteipennis*, and other swamp inhabitants. The

ıditions are discussed more fully under the account of Rhamphidia ıge 831). The larvae are reddish brown in color, and rather sluggish. e of the larvae found on April 20 pupated on the 22d and emerged as adult female on the 30th, a pupal duration of eight days. An additional pa was taken, associated with larva of *Pseudolimnophila luteipennis*, *inornata*, *Tricyphona inconstans*, and other species.

arva.— Length, 20 mm.
Diameter, 1.8 mm.

'oloration brown; dorsum marked with light and dark brown; a narrow, indistinct, dark wn, median line, with a broader zigzag brown line on either side; ventral surface a little er.

ody covered with a short, dark pubescence at sides of segments, at margins longer and e conspicuous. Chaetotaxy as follows: tergites with six strong setae in transverse ement, the outermost in pairs; two strong setae on each pleural annulus; posterior ring sternites with eight strong setae, arranged in four pairs. Spiracular disk (Plate XCV,) pale, surrounded by six approximately equal lobes which are heavily marked with wn; dorsal and lateral pairs pointed, ventral pair blunt; ventral lobes with apical half y black, on ventral inner margin continued dorsad, almost contiguous on midline; inner of dorsal and lateral lobes suffused with dark brown, proximal margin of dorsal lobe duced inward so that the marks are almost contiguous on median line; beneath each acle a transversely rectangular, dark brown mark. Anal gills with four anterior lobes ch are long and slender, and a pair of rudimentary blunt posterior gills (Plate XCII, 509). ead capsule and mouth parts as in genus. Mentum (Plate XCV, 524) seven-toothed, al point the longest. Hypopharynx (Plate XCV, 525) bluntly five-toothed.

upa.— Length, 15.3 mm.
Width, d.-s., 2.3–2.4 mm.
Depth, d.-v., 2.1–2.2 mm.

oloration dark brown; abdominal incisures paler.

orm relatively stout. General features as in genus. Cephalic crest consisting of two t lobes with microscopic setae. Maxillary palpi strongly curved at tip, but not entirely rved. Pronotal breathing horns short, tips a little enlarged.

odominal tergites with spines weak, on median area of each row weak or lacking; on rmediate segments about fifteen spines; pleurites with only a single weak spine on basal ; on posterior ring a rudimentary anterior spine and a somewhat larger posterior spine; ites similarly armed to tergites, but spines fewer in number and larger, on segment out twelve in number; on base of posterior ring a large spine on either side median line a small setiferous tubercle laterad of each. Female cauda with tergal valves of ovi- or long and straight, sternal valves a little shorter; cauda with the usual six dorsal lobes, e terminating in slender spines; at end of eighth sternite six large spines; dorsal spines ced to a single small pair, one near each lateral margin.

epionotype.— Larch Meadows, Ithaca, New York, April 20, 1917.
eanotype.— With type.
aratypes.— Two pupae with type pupa.

Tipula usitata Doane

1901 *Tipula usitata* Doane. Journ. N. Y. Ent. Soc., vol. 9, p. 124.

A large number of fully grown larvae of an unknown species of Tipul were found beneath the bark of a fallen tree at Stanford University California, on March 22, 1915, by Harold Morrison. They were sen to the writer at Ithaca, New York, and emerged as adults on April 1 The immature stages are very distinct, closest perhaps to *T. trivittat* which also lives beneath the bark of decaying trees. Nothing is know of the habits of the adult flies.

Larva.— Length, 25–27 mm.
Diameter, 3–3.2 mm.

Coloration pale greenish yellow, darker above.

Form terete. Body with a very sparse pubescence. Chaetotaxy as follows: tergite (Plate XCV, 527) with a posterior row of eight setae, the middle pair of each side very closel approximated; a seta near lateral margin at base of posterior ring, on a level with pleura seta; pleurites, one seta on each ring; sternites with eight setae in closely approximated pai on posterior ring. Spiracular disk (Plate XCV, 528) surrounded by six lobes; dorsal an lateral pairs slender, tips of former acute; ventral lobes blunt; ventral lobes with tips blac ened, continued down proximal margin of lobes as a paler brown line; lateral lobes with inne face narrowly blackened, this mark not reaching spiracles; dorsal lobes with entire inner fac bulging, intensely black, the marks contiguous at their basal inner angle; an indistinct brow spot underneath each spiracle, in some specimens this mark continuous with that of ventra lobes; lobes not fringed with hairs. Spiracles large, separated by a distance about equal to or a little greater than, diameter of one. Anal gills short and blunt, strongly protuberant surrounding anus as four fleshy lobes (Plate XCII, 510).

Head capsule as in genus. Mentum broad, with seven to nine teeth, in the latter cas the outermost pair very small. Hypopharynx with three or five very blunt teeth. Antenn much shorter and stouter than in most species of Tipula, the length only a little greater tha twice the diameter, at apex with a blunt conical papilla and a few small, cylindrical sens pegs. Mandible powerful, with two or three flattened teeth on ventral cutting edge.

Pupa.— Length, 15–16.8 mm.
Width, d.-s., 2 mm.
Depth, d.-v., 2.3–2.4 mm.

Coloration pale brown; posterior margin of abdominal rings pale; lateral margin o abdomen conspicuously pale yellowish white.

Form slender. Pronotal breathing horns narrow, a little expanded at tips. Leg sheath ending on a level.

Abdominal spines very strong, but few in number; tergites with four to six spines; pleurite with a single weak spine on each ring; sternal spines very strong, five or six in number, thos on segment 7 subequal in size to those on segment 8; no sternal spines on base of posterio ring. Male cauda with posterior dorsal lobe very strong, pale, tips acute; lateral lobes greatl

educed in size, the median pair represented only by two blunt brown tubercles; eighth egment with the usual six strong ventral and lateral lobes. Female ovipositor with valves mall; sternal valves short and broad, much shorter than tergal valves.

Nepionotype.— Stanford University, California, April 15, 1915.
Neanotype.— With type, bred April 15, 1915.
Paratypes.— Numerous larvae and pupae with type.

Tipula trivittata Say

1823 *Tipula trivittata* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 26.

The larvae and the pupae of *Tipula trivittata* live beneath the bark of much-decayed prostrate trunks or under the layers of moss that often cover fallen trees. Abundant larvae were found on March 22, 1913, and were placed in rearing, adults emerging on April 26. On April 16, 1914, larvae of two distinct sizes—some very small and some nearly fully grown—occurred in abundance beneath moss (*Entodon seductrix* [Hedw.] C. Muell., *Brachythecium acuminatum* [Hedw.] Kindb., *Hypnum Haldanianum* Grev., and *Mnium sylvaticum* Lindb.) on prostrate decaying elms, sycamores, and other trees, at Renwick Park, Ithaca, New York.

The adult flies are among the commonest of the eastern species of Tipula, and fly during a large part of the season.

Larva.— Length, 24–25 mm.
Diameter, 2.7–3 mm.

Coloration pale brownish yellow, a little paler beneath.

Form moderately elongated, terete. Pubescence very short or practically lacking. Setae n anterior segments strong, on posterior segments shorter. Chaetotaxy as follows: tergites with a posterior row of six setae, the two middle punctures each with a single seta, he two lateral punctures each with two setae; pleurites with a single seta on each ring; sternites with two rows of setae, the anterior row consisting of two closely approximated roups of two setae each, the posterior row consisting of a single large seta, laterad of which a minute bristle. Spiracular disk (Plate XCV, 529) surrounded by six lobes; lateral pair ng and slender; dorsal pair a little shorter, slender; ventral lobes blunt; ventral lobes with jet-black mark on inner face; lateral lobes with dark markings represented only by a very nall linear dash; dorsal lobes with a small black area. Spiracles large, separated by a distance a little less than diameter of one. Anal gills indistinctly lobed, four in number, two n either side, very blunt and protuberant.

Head capsule as in genus, the mouth parts almost as in *T. usitata*. Mentum broad, with even teeth. Hypopharynx with five teeth, the three middle ones the longest, subequal size. Antenna shorter and stouter than is usual in the genus.

Pupa.— Length, 19–20 mm.
Width, d.-s., 2.5–2.6 mm.
Depth, d.-v., 2.8–3 mm.

Coloration dark brown; abdomen yellow, with a broad sublateral brown stripe on both sternites and tergites; abdominal segments beyond posterior row of spines brighter, more yellowish.

Characters of head as in genus. Cephalic crest very small. Labrum broad. Pronotal breathing horns short, slightly curved. Mesonotal prescutum with fine transverse wrinkles, two blunt lateral tubercles, and behind these, on either side of median line, two smaller flattened ledges which are often bifid at their tips. (Similar ledges, but much less prominent, occur in *T. usitata*.)

Abdominal tergites with subapical armature weak, spines varying in number from six to eight, those of posterior segments larger; pleural spines long and slender, one on each ring; sternal spines powerful, four to six in number, no spines on base of posterior ring. Female cauda with sternal valves long and slender, but little shorter than tergal valves; dorsal lobes of cauda four in number, posterior pair very powerful, lateral pair small, anterior median pair lacking.

Nepionotype.— Ithaca, New York, March 22, 1913.
Neanotype.— With type.
Paratypes.— Numerous larvae and pupae with types, April 26, 1917; March 22, 1913; etc.

Tipula ignobilis Loew

1863 *Tipula ignobilis* Loew. Berl. Ent. Ztschr., vol. 7, p. 280.

The adult flies of *Tipula ignobilis* are not common in collections, due in part to their retiring habits. The larvae, however, are common in their preferred habitat, saturated moss cushions.

At Orono, Maine, numerous larvae were taken in wet moss on June 17, 1913, associated with other larvae, such as those of Rhaphidolabina, Tricyphona, Pedicia, and *Tipula nobilis*. At Ithaca, New York, on April 23, 1917, four very small larvae were found in wet cushions of moss (Amblystegium). They grew very rapidly, emerging as adults on May 21. On May 22 this moss was carefully examined and about thirty fully grown to rather immature larvae of this species were taken. They were associated with equally numerous larvae of *Dicranomyia stulta* O. S. At Needham's Glen, the species occurred in the same moss that earlier in the season harbored *Tipula collaris* and *T. oropezoides*. On June 14 two teneral adults of *T. ignobilis* were captured, in company with *Dicranomyia stulta*, *Geranomyia canadensis*, *Dactylolabis montana*, and other species. The species is very common at the Indian Ladder, Helderberg Mountains, New York.

Larva.— Length, 16.5–18 mm.
Diameter, 2.5–2.6 mm.

ration grayish brown, paler gray beneath; thoracic segments conspicuously reddish

y terete. Dorsum covered with a short, dark pubescence, which gives upper surface k color. Chaetotaxy as follows: tergites (Plate XCVI, 530) with a posterior trans- ow of two setae near base of posterior ring; sternites (Plate XCVI, 531) with about setae, anterior median row consisting of two large setae, each with a tiny seta ad of it, the posterior pair of large setae more widely separated, laterad of each of these sely approximated smaller setae. Spiracular disk (Plate XCVI, 532) surrounded moderately long lobes fringed with rather short, pale hairs; tips of ventral lobes with circular area provided with a sensory seta; inner face of spiracular disk with the gs pale, ventral lobes with an indistinct capillary brown line; two brown spots beneath piracle. Spiracles large. Anal gills eight, consisting of a transverse row of four slender, two-branched lobes (Plate XCII, 511).

tum of head capsule with median point prominent, the three lateral teeth of either nall, moderately acute. Mandible with about four teeth, in addition to the large rosthecal tooth.

a.— Length: male, 12 mm.; female, 14–15 mm.
Width, d.-s.: male, 1.7–1.8 mm.; female, 1.8–2 mm.
Depth, d.-v.: male, 1.9–2 mm.; female, 2.1–2.2 mm.

d and mouth parts as in genus. Pronotal breathing horns rather long and slender, little expanded. Leg sheaths rather short, just exceeding third abdominal segment; gs a little the longest, the other tarsi ending about on a level.

ominal tergites with armature weak, spines small; pleurites and sternites with spines r larger and more powerful; sternites with subterminal row consisting of twelve to spines, those of the sixth and seventh segments larger; no spines at base of posterior leural spines setiferous, very weak, one on basal ring, two on posterior ring. Male with ventral lobes widely separated, terminating in slender, curved spines directed ; dorsal lobes slender, approximated on dorso-median line. Female cauda (Plate 533) with tergal valves a little longer than sternal valves, the latter at their tips ating in slender points directed ventrad and laterad; dorsum of cauda with the usual s, posterior pair the largest, terminating in two distinct points; eighth segment on and sternal region with six very powerful, curved spines.

onotype.— Ithaca, New York, June 3, 1917.
notype.— With larva, June 3, 1917.
types.— Numerous larvae and pupae, June 1 to 12, 1917.

a abdominalis (Say)

23 *Ctenophora abdominalis* Say. Journ. Acad. Nat. Sci. Phila., vol. 3, p. 18.

ula abdominalis is the largest eastern species of the genus, altho specimens of *T. caloptera* are nearly as large. The adult flies are e wing in late August and September, and even, in fewer numbers, e and July.

The large, fleshy larvae occur beneath or among drift at or near margins of streams. They are usually abundant under saturated dec ing leaves or under tussocks of grass at the edge of the water. T are entirely herbivorous, feeding on diatoms, decaying plant tiss and other vegetable matter. The larvae are readily distinguished f all other species of the genus by the small spiracles and the bifid or s lobes surrounding the spiracular disk. Pupation takes place in the m or earth at the water's edge. Malloch's *Tipula* sp. 2 (1915–17b:2 201) seems to refer to *T. abdominalis*, but the mouth parts of his sp mens do not seem to be normal.

Larva.— Length, 55–65 mm.
Diameter, 7.5–10 mm.

Coloration pale grayish brown; anterior end darker.

Form stout, terete, thin-skinned. Posterior ring of abdominal segment, both above below, with a naked transverse welt, which bears the setae; this welt very protuberan its lateral ends, almost like a pair of prolegs. Skin naked, except for a microscopic de and the rather short, delicate setae. Chaetotaxy as follows: tergites, on welt at about length, a transverse row of eight setae, the middle pair of each half closely approxim pleurites with a single seta opposite basal ring, and two opposite posterior ring, arra one behind the other; sternites with four pairs of setae on welts, anterior middle pair c together than posterior lateral pair. Spiracular disk (Plate XCVII, 537) moderately la flattened, truncated, surrounded by six deeply bifid and irregular lobes; ventral lobes gate, with a blunt basal branch bearing two setae; posterior branch longer, indistin bifid at tip and with a few setae and several hairs; lateral lobes deeply bifid, the ve one armed with lateral setae; dorsal lobes small, simple; inner faces of dorsal and la lobes with a narrow dark brown stripe, ventral lobes with two narrow, usually indis lines, these markings broadest and darkest on dorsal lobes. Spiracles very small, circ separated by a distance about equal to four times diameter of one. Anal gills six, long slender, the middle one on either side a little shorter than the others. Pleural regio penultimate segment of body with a blunt setiferous tubercle.

Head capsule and mouth parts about as in genus. Mentum (Plate XCVII, 536) bro transverse, anterior margin with seven to nine teeth, in the latter case the outermost t very indistinctly separated from the sublateral teeth. Hypopharynx broad, anterior ma with teeth very indistinct.

Pupa.— Length of cast pupal skin, about 35 mm.

Pronotal breathing horns short, straight, cylindrical; apex short, and but little if a expanded. Details of mouth parts as in other species of genus. Wing sheaths en before apex of second abdominal segment. Leg sheaths extending to about opposite of third abdominal segment; fore tarsi the shortest, hind tarsi the longest, ends of t sheath thus forming a broad, inverted U-shaped notch.

Abdominal armature generally weak. Tergites (Plate XCVII, 538) with subterminal broken, consisting of an anterior median pair of large spines, laterad of which are tw

e smaller spines; close to ends of row a bifid setiferous spine; pleurites with spines long, der, directed strongly caudad, tips narrowly bifid, bearing a seta in notch; basal spine largest; posterior spines two in number, anterior dorsal one the smaller; sternites (Plate VII, 539) with posterior row unbroken, of comparatively few spines, there being about en excluding the two larger spines at ends of row; the innermost of the large lateral spines picuously bifid, bearing a stout seta in its notch; base of posterior ring on either side of ian line with a powerful conical spine which is acutely tipped. Female cauda as in genus, al valves conspicuously shorter than the long tergal valves; the six dorsal lobes power- chitinized, more or less bifid at tips; dorsal lateral lobes at end of eighth segment before tips.

epionotype.— Cascadilla Creek, Ithaca, New York, May 31, 1913.
eanotype.— Cast pupal skin, reared at Ithaca, September, 1911.
aratypes.— Abundant larvae from type locality.

ula taughannock Alex.

1915 *Tipula taughannock* Alex. Proc. Acad. Nat. Sci. Phila., p. 476–479.

Tipula taughannock is of exceptional interest in the striking color orphism that it shows, the females being black and yel'ow, the males t yellowish. The following account of the habits of the adult flies aken from the writer's field notes:

ne 12, 1915. Deciduous forest association of the southern Helderberg Mountains, near illage of New Salem, Albany County, New York. This association is an open deciduous t, with an undergrowth of Cystopteris, Geranium, Caulophyllum, and Impatiens. It is a open woods, having an eastern exposure and with the talus slopes so old that an extensive ation has sprung up. The great boulders scattered about thru the woods have come the high Silurian and Devonian cliffs above. The woods are of such a nature that much ght penetrates to the ground beneath. The forest cover shows a striking lack of conif- species, but the following deciduous species are common: butternut, hop hornbeam, maple, basswood, white ash. The shrubbery consists of mountain maple, bladdernut, a few dogwoods. The dominant herbage consists of jack-in-the-pulpit, wild ginger, root, bishop's-cap, false bishop's-cap, blue cohosh, white baneberry, herb robert, touch- ot, waterleaf, bedstraw, and other characteristic flowering plants in fewer numbers, ll as several ferns, such as the bulbous bladder fern, maidenhair, and, on the rocks, alking fern. The crane-fly under consideration is very common in these woods. The rtion of males to females is about one hundred to one, but this is due, in large part st, to the very secretive habits of the latter. The males are untiring, almost always ng along, silently and relentlessly, in quest of their mates. They pass in and out among ense herbage, usually close to the ground, occasionally fluttering up a tree trunk or over ssy boulder which is covered with various bryophytes and walking ferns. They are ent upon their quest that they are readily scooped up by hand. If this is attempted ails, however, they become instantly alarmed and fly away with great speed, their flight is time having a strong undulating motion. In a position of rest, the male almost s hangs on the under surface of a leaf, with the body directed straight toward the d. Several specimens of this species, as well as of *Tipula trivittata* Say and *T. senega* were found dead in spider's webs. These small webs, made by species of idae and Linyphiidae, are very common on and between the leaves of herbaceous plants re presumably intended for smaller game. The large Tipulas are probably taken in cident.

The females are more active when in flight than are their mates and are capable of mov very rapidly. Their flight is a rapid, fluttering progression along the ground. Copulat takes place on either the upper or the lower surface of leaves, usually near the ground. Sor times copulation is end to end, with the heads directed away from each other; at other ti it is face to face, the bodies being arcuated into a convex loop.

The larva almost certainly lives among or beneath the decaying leaves and débris wh cover the talus slope.

Tipula macrolabis Loew

1864 *Tipula macrolabis* Loew. Berl. Ent. Ztschr., vol. 8, p. 58.

Tipula macrolabis is distinctly northern in its distribution. It is characteristic fly of northern deciduous woods in June. The followi notes were made near the village of Indian Castle, Herkimer Coun New York, on June 13, 1915:

A small woodland stream with a forest cover of trees such as hemlock, beech, slipp elm, and basswood, and a ground cover of false solomon's seal, wood nettle, wild ging herb robert, touch-me-not, waterleaf, sarsaparilla, and the two abundant ferns maidenh and the bulbous bladder fern. The males of *T. macrolabis* were in search of the fema and fluttered up the tree trunks often to a height of ten or fifteen feet, flying close to ground, around brush heaps, hovering about the leafy ends of branches, and perform similar actions in their untiring quest for their mates. They occurred in company w males of *T. fuliginosa* and *T. valida*, which were similarly engaged in searching for the fema

Tipuline No. 1 (possibly *Tipula iroquois* Alex.)

1863 *Tipula cincta* Loew. Berl. Ent. Ztschr., vol. 7, p. 288–289, not *T. cincta* Gm Syst. Nat., ed. 13, vol. 1, p. 2820 (1792).
1915 *Tipula iroquois* Alex. Insec. Inscit. Menst., vol. 3, p. 128.

The larva discussed below has never been reared and is mentio here principally because of its interesting habitat. It is referred *Tipula iroquois* with considerable doubt.

The larva lives among dense mats of an aquatic moss, a Hypnu (Rhynchostegium) of the *dilatatum* group, in the most rapid-flowi streams. At Coy Glen, Ithaca, New York, these larvae are especial frequent, often living at the brink of falls or rapids in the most rushi waters. A study of the structure of the larva reveals numerous sm but prominent tubercles, which doubtless assist the insect in clinging the moss stems. The gills are large, but no better developed than many aquatic species of the genus that live in much less lotic conditio The green color and the transverse rows of tubercles on the body give t larva a strong resemblance to its mossy habitat. The larvae are ve sluggish and crawl but slowly, often appearing quite dead for long perio of time.

Associated with these larvae in Coy Glen, the following characteristic orms of insect life occur:

Plecoptera: a small species of Perlidae.
Ephemerida: Ephemeridae, such as Baetis, *Iron fragilis*, Ephemerella, and others.
Trichoptera: Ryacophilidae, Hydroptilidae, and other forms.
Neuroptera: Chauliodes larvae.
Diptera: Chironomidae, a few; Psychodidae, *Psychoda albitarsis* Banks; Stratiomyiidae; Anthomyiidae, *Limnophora torreyae* Joh.; and other groups.
Coleoptera: Parnidae, larvae of *Psephenus lecontei* (Lec.), and adult beetles of a species of Elmis in large numbers.

Up to the present time it has been found impossible to rear this larva o the adult condition, chiefly because of the constant need of well-aërated vater and the difficulty of supplying it. By placing the larvae in the folds f moistened cheesecloth, it was possible on one occasion to carry the pecies to the pupal state, but no further. It will be of interest to scertain the identity of this conspicuous larva.

Larva.— Length, 24–25 mm.
Diameter, 2.6–3 mm.

Coloration above, dark green with a brown pattern; beneath, light green with indistinct ansverse brown lines; on dorsum a pale longitudinal mark on sides of posterior ring, cross- g sutures between segments onto extreme base of anterior ring of following segment, the ark area of each segment thus appearing cruciform, this cross-shaped mark spotted and arbled with darker in transverse rows; base of gills and center of spiracular disk light green living, healthy larvae.

Form moderately terete, each segment with transverse rows of small, prominent tubercles, me of which are provided with setae. On dorsum of posterior ring a subterminal row of x tubercles, the middle one on each side with two setae, the remaining four tubercles unise- se; two rows of smaller naked tubercles at base and middle of posterior annulus; basal nulus with four transverse rows of small naked tubercles; pleurites with three tubercles, small seta on basal ring ventrad of basal tubercle, and two setae on posterior ring ventrad d cephalad of posterior tubercle; sternites on posterior ring with six setae, four on ante- or row, the two middle ones very tiny. Spiracular disk almost as in *T. collaris*, *T. ignobilis*, d similar species, surrounded by six lobes fringed with moderately long hairs; inner face lobes somewhat pale; ventral lobes with a narrow, capillary, dark brown line, extending om tip toward base; lobes narrowly and more or less indistinctly margined with brown; o brown spots at base of each ventral lobe, underneath each spiracle; dorsal and lateral bes jutting backward at tips into fleshy conical points. Spiracles circular, moderately rge, separated by a distance about equal to one and one-half diameter of one. Anal gills th eight branches, rather short and stout, with two lateral divergent branches on either le and an inner pair with one ventral and one posterior branch (Plate XCII, 512).

Head capsule and mouth parts of almost normal tipuline appearance. Mentum with outer plate forming the unusually long apical point, inner plate adding three teeth on either side, margins bulging. Antenna with apical papillae somewhat flattened, surrounded by three sense pegs.

(Described from abundant specimens, Coy Glen, Ithaca, New York, April 23, 1914.)

Tipuline No. 2

The larva discussed below is known only from a single, apparently fully grown, specimen. The writer has no clue as to which species it represents, altho from the larval structure it is obviously allied to *Tipula selene* Meig. of Europe.

Larva.— Length, 23 mm.
Diameter, 3 mm.

Coloration, a rather uniform pale yellowish or reddish brown.

Body covered with a rather sparse, long pubescence, setae unusually long and powerful. Chaetotaxy as follows: tergites (Plate XCVI, 534) with two strong lateral setae near posterior margin and an additional one at extreme lateral margin of ring; pleural setae, one on basal ring, two, one behind the other, on posterior ring; sternites with a transverse pair of powerful setae near extreme lateral margin, and two anterior pairs of much smaller setae. Spiracular disk (Plate XCVI, 535) with four elongated, cylindrical, chitinized horns which are narrowed to the acute, blackened, slightly curved tips; longer dorsal pair rather closely approximated, lying almost parallel, with tips a little curved dorsad; shorter and more slender lateral horns directed ventrad at tips, at base on inner face with a powerful seta, the large black spiracles lying above base of lateral horns; ventral lobes, if present, very blunt and indistinct. Anal gills not protruded in the only specimen available.

Head capsule and mouth parts rather normal but showing the following points of difference from the usual Tipula type: Mentum almost completely split, apical point long and narrow; the three lateral teeth on either side blunt, lateral pair tending to be reduced.

Hypopharynx with five blunt teeth. Antenna short, stout, length only about twice diameter, at tip with a subglobular, feebly chitinized papilla.

(Described from a single larva found beneath a stone in a field near Taughannock Falls, Tompkins County, New York, May 1, 1912.)

Genus **Nephrotoma** Meigen (Gr. *kidney + I cut*)

1800 *Pales* Meig. Nouv. Class. Mouch., p. 14 (*nomen nudum*).
1803 *Nephrotoma* Meig. Illiger's Mag., p. 262.
1834 *Pachyrrhina* Macq. Hist. Nat. Ins., Dipt., vol. 1, p. 88.

The large genus Nephrotoma, including some one hundred and fifty described species, is very close to Tipula in all respects. The writer cannot attempt to separate the immature stages of the genus from those of Tipula, on the scanty material that has been available for study.

In Europe, Beling and others have described the life histories of about ght of the commoner species. The following species live in earth, neath a covering of leaf mold: *analis* (Schum.), *cornicina* (Linn.), *lineata* cop.), *maculata* (Meig.), *lunulicornis* (Schum.), *pratensis* (Linn.). The llowing have been described as living in decaying wood, some of the cords apparently being in error: *cornicina* (Linn.), *crocata* (Linn.), *neata* (Scop.), *quadrifaria* (Meig.). Some of the species are injurious young seedlings, especially those of coniferous plants.

In North America the commonest species, *N. ferruginea* (Fabr.), has en discussed several times in its economic relations to agriculture. Hart 898 [1895]:218–219) gives an excellent description of the immature ages, while Malloch (1915–17 b:206) gives supplementary notes and ures of the same species. The immature stages live in sand or earth. *. virescens* (Loew) was bred from a larva found in moss on Plummers land, Maryland, on April 5, 1913, by R. C. Shannon. *N. eucera* (Loew) d *N. polymera* (Loew) have been reared from larvae taken under leaf old in woods by Mabel M. Alexander.

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EXPLANATION OF ABBREVIATIONS USED ON PLATES

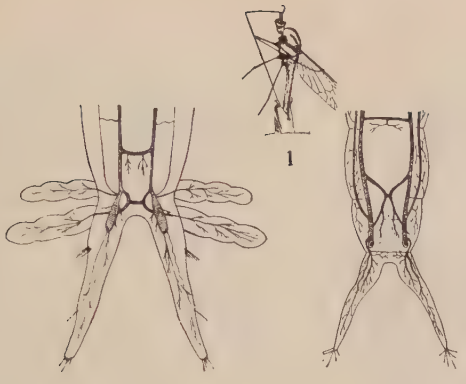
A=antenna	Pl=pleuron
C=cardo	PM=prementum
Lb=labium, or labial lobes	S=stipes
M=mentum	SM=submentum
Md=mandible	Sp=spiracle
Mx=maxilla	St=sternite
P=palpus, or palpal sheath	T=tergite

Memoir 34, *An Economic Study of Farm Layout*, the fourth preceding number in this series of public tions, was mailed on January 31, 1921.

Memoir 35, *Some Effects of Potassium Salts on Soils*, the third preceding number in this series of public tions, was mailed on January 29, 1921.

Memoir 36, *Resistance of the Roots of Some Fruit Species to Low Temperature*, the second preceding numb in this series of publications, was mailed on January 19, 1921.

Memoir 37, *A Modified Babcock Method for Determining Fat in Butter*, the next preceding number in th series of publications, was mailed on December 10, 1920.



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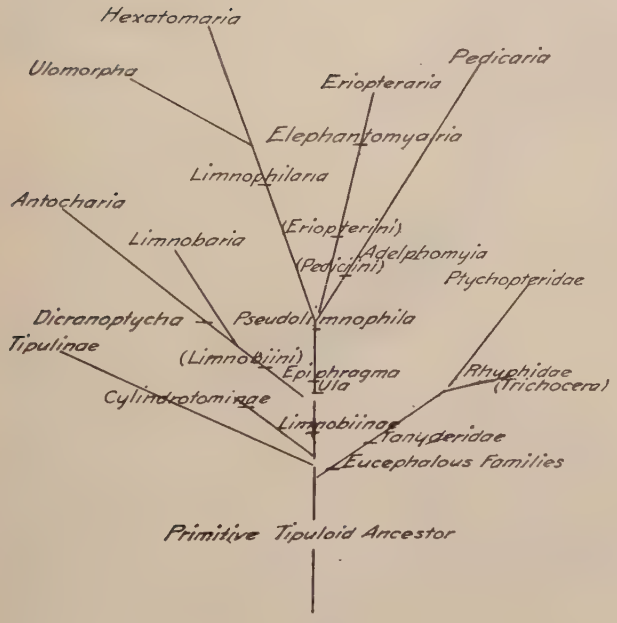
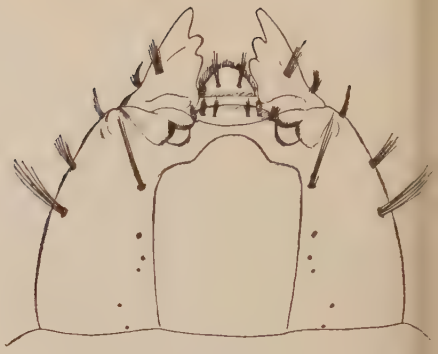


4

1, *Eriocera spinosa* emerging from pupal hull.
2–3, Spiracular disk and tracheation of larvae: 2, *Antocha saxicola* (apneustic); 3, *Dicranota bimaculata* (metapneustic), after Miall
4, Phylogenetic tree

5



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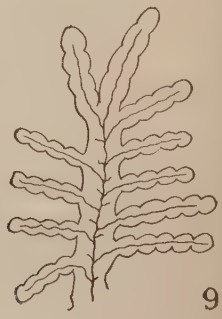

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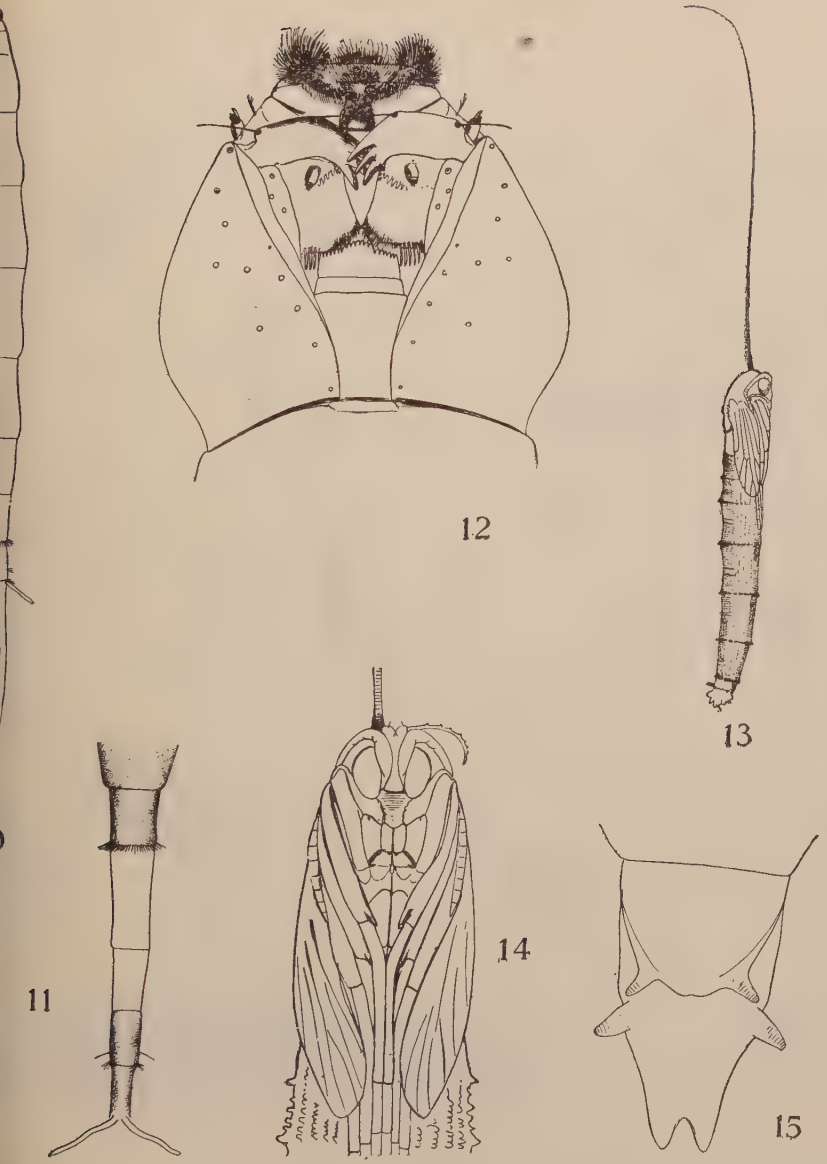
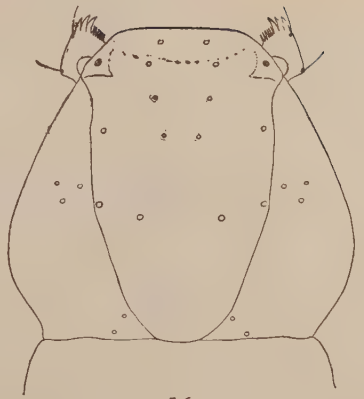
PROTOPLASA FITCHII, SUPPOSITION

5, Dorsal aspect; 6, spiracular disk; 7, head, dorsal aspect; 8, head, ventral aspect
anal gill



PTYCHOPTERA RUFOCINCTA

larva: 10, dorsal aspect; 11, breathing tube extended; 12, head, ventral aspect
upa: 13, lateral aspect; 14, ventral aspect; 15, female cauda, ventral aspect



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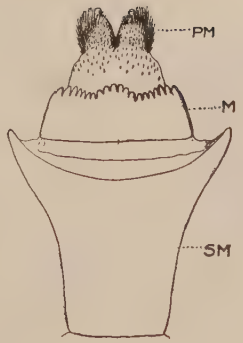

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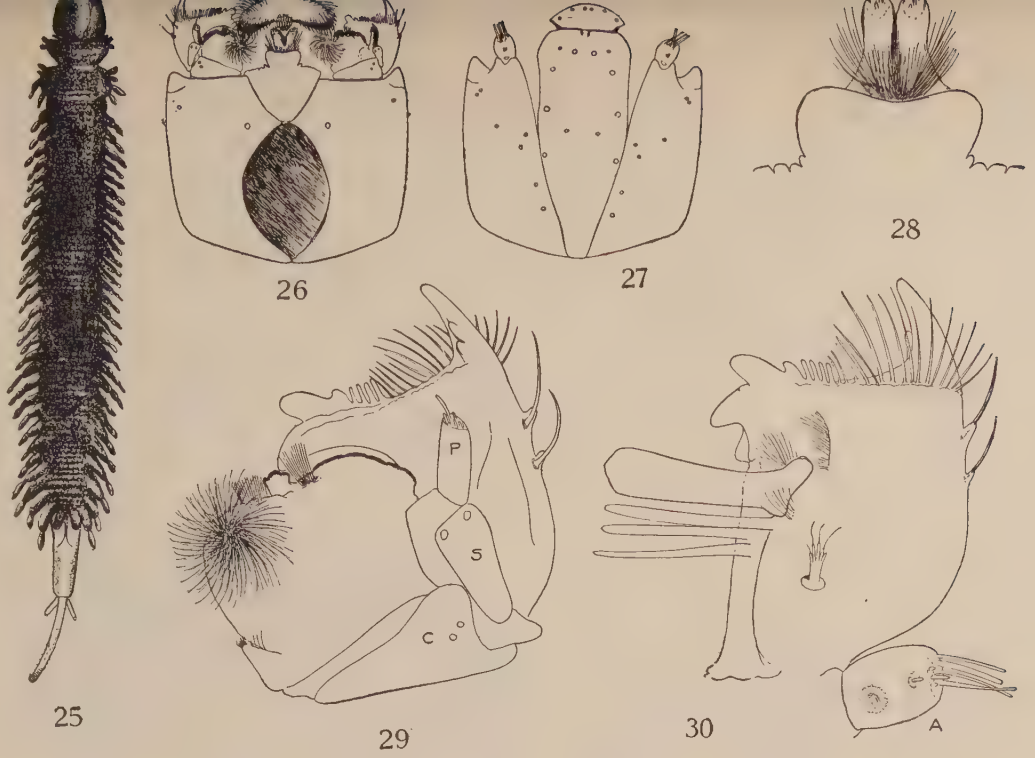
PTYCHOPTERA RUFOCINCTA

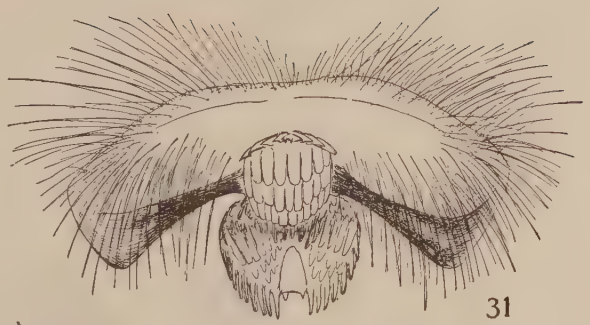
Larva: 16, head, dorsal aspect; 17, labium, ventral aspect; 18, antenna; 19, mandible and maxilla; 20, plumose hairs of head

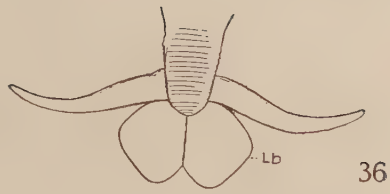
Pupa: 21, arrangement of leg sheaths; 22,

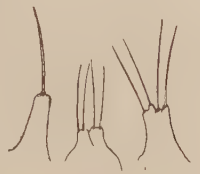


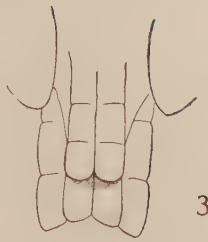
BITTACOMORPHELLA JONESI, LARVA

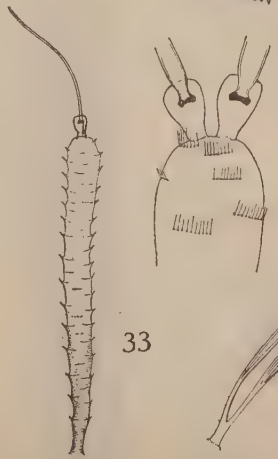
25, Dorsal aspect; 26, head, ventral aspect; 27, head, dorsal aspect; 28, labium, ventral aspect; 29, mandible and maxilla, ventral aspect; 30, mandible and antenna, dorsal aspect







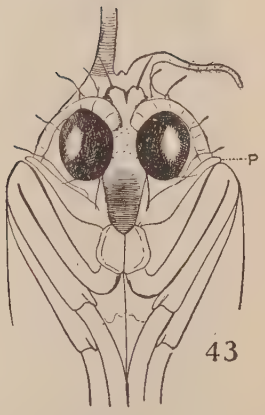




BITTACOMORPHELLA JONESI

Larva: 31, labrum-epipharynx; 32, apex of pseudopod, and claw; 33, body projection; 34, body projection, enlarged; 35, branched hairs on body;

42



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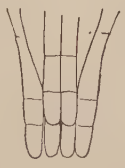

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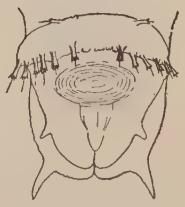


48

BITTACOMORPHA CLAVIPES

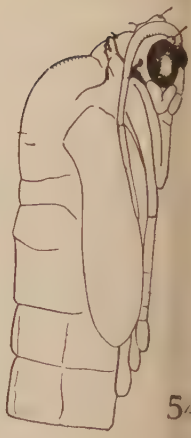
Larva: 41, labium; 42, mandible and antenna, dorsal aspect
Pupa: 43, ventral aspect; 44–46, types of abdominal tubercles; 47, arrangement of leg eaths; 48, male cauda, dorsal aspect

49

51

52

53



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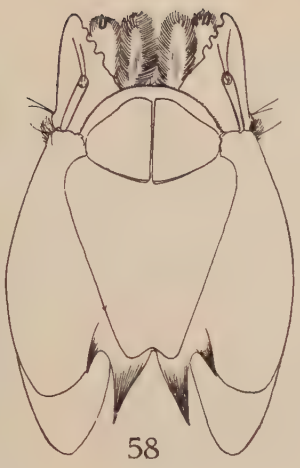
56

TRICHOCERA SP. (REGELATIONIS, SUPPOSITION)

Larva: 49, dorsal aspect; 50, spiracular disk, lateral aspect; 51, spiracular disk, dorsal aspect; 52, head, ventral aspect (after De Meijere); 53, head, dorsal aspect (after De Meijere)
Pupa: 54, lateral aspect; 55, female, ventral aspect; 56, female cauda, lateral aspect

57



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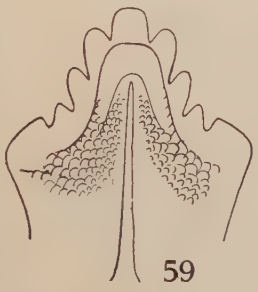

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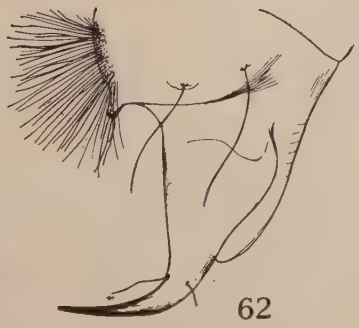
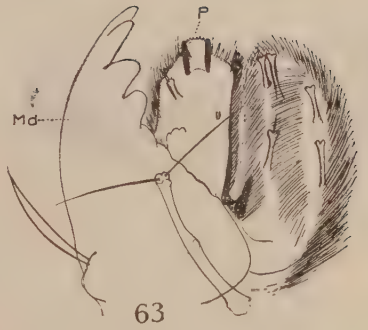


62

61

ANTOCHA SAXICOLA

va: 57, dorsal aspect; 58, head capsule, dorsal aspect; 59, mentum
ba: 60, ventral aspect; 61, pronotal breathing horn, lateral aspect; 62, female cauda,
l aspect



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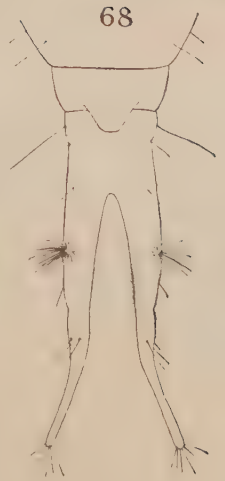

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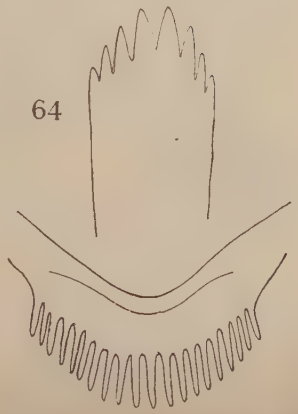

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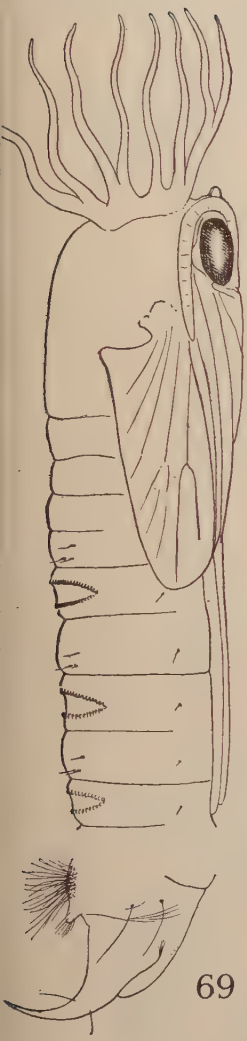
ANTOCHA SAXICOLA, LARVA

63. Mandible and maxilla, ventral aspect; 64, hypopharynx; 65, antenna; 66, pupatum, aberration; 67,



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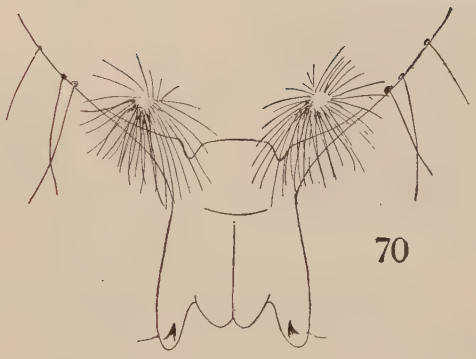

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ANTOCHA SAXICOLA, PUPA

Lateral aspect; 70, male cauda, dorsal aspect; 71, fifth abdominal segment, dorsal aspect (diagrammatic)

72

73

74

75

76

77

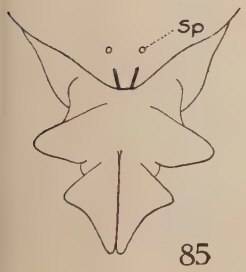
78

ELLIPTERA OMISSA (AFTER MILK)

Larva: 72, dorsal aspect; 73, head capsule, ventral aspect; 74, head capsule, dorsal aspect; 75, mandible; 76, spiracular disk

79

81



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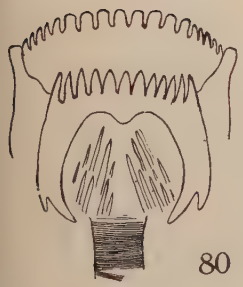

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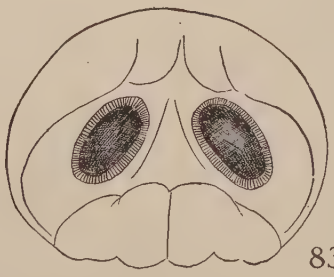
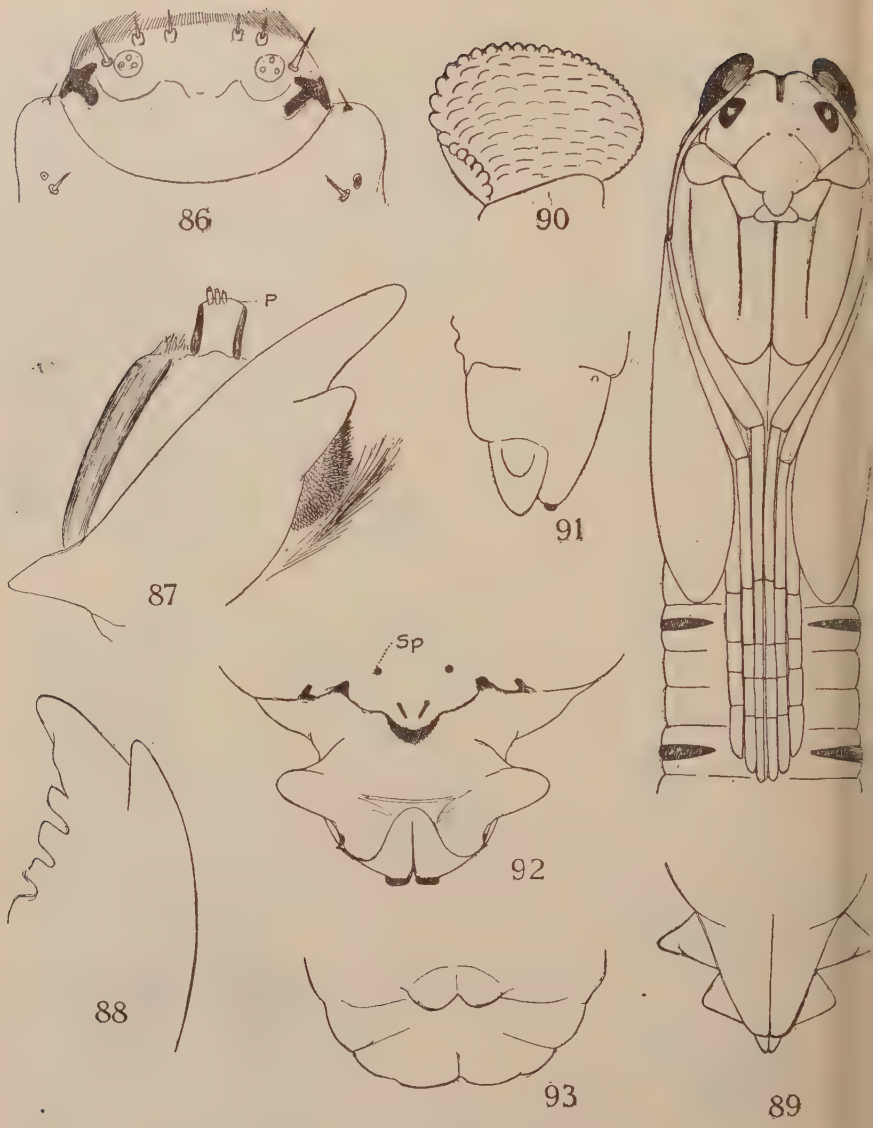


83

LIMNOBIA CINCTIPES

Larva: 79, head capsule, dorsal aspect; 80, hypopharynx; 81, mentum; 82, antenna; 83, tracular disk

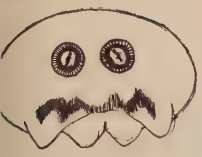
Pupa: 84, female, lateral aspect; 85, female cauda, dorsal aspect



LIMNOBIA CINCTIPES

Larva: 86, labrum-epipharynx; 87, mandible and maxilla; 88, mandible; 93, spiracular disk, dorsal aspect

Pupa: 89, female, ventral aspect; 90, pronotal breathing horn, lateral aspect; 91, male cauda, lateral aspect; 92, male cauda, dorsal aspect



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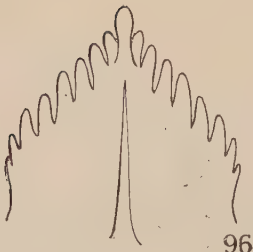

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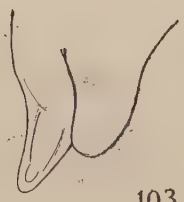


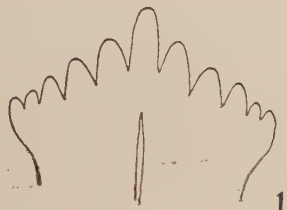
103

LIMNOBIA TRIOCELLATA AND L. FALLAX

Limnobia triocellata: 94, spiracular disk
Limnobia fallax, larva: 95, labrum-epipharynx; 96, mentum; 97, antenna; 98, mandible; maxilla
Limnobia fallax, pupa: 100, mouth parts; 101, pronotal breathing horn; 102, female uda, dorsal aspect; 103, female cauda, lateral aspect

104

108



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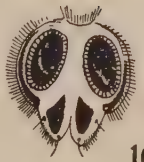

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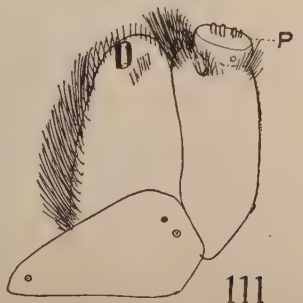

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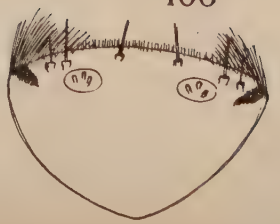
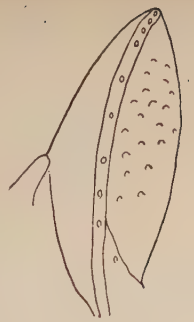


DICRANOMYIA BADIA AND D. STULTA

Dicranomyia badia: 104, spiracular disk
Dicranomyia stulta, larva: 105, spiracular disk; 106, labrum; 107,

112

113



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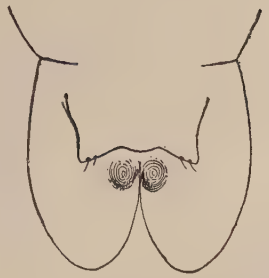

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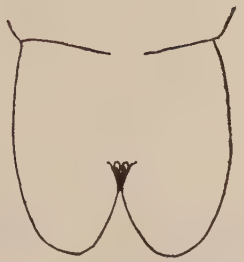

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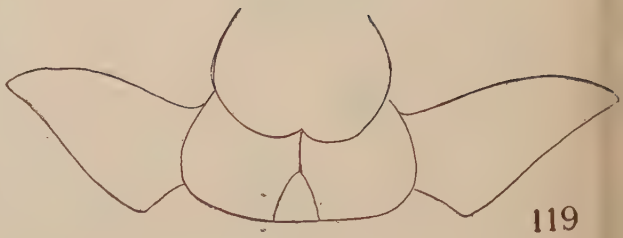
117

DICRANOMYIA STULTA, PUPA

112, Mouth parts; 113, pronotal breathing horn, dorsal aspect; 114, pronotal breathing horn, lateral aspect; 115, male cauda, dorsal aspect; 116, male cauda, ventral aspect; 117, male cauda, lateral aspect



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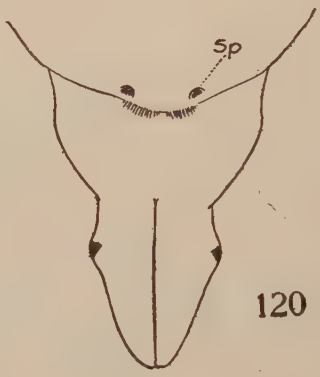


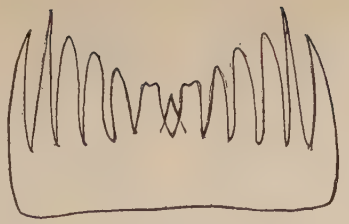
120

118

DICRANOMYIA BADIA, PUPA

118, Lateral aspect; 119, mouth parts; 120, female cauda, dorsal aspect

121



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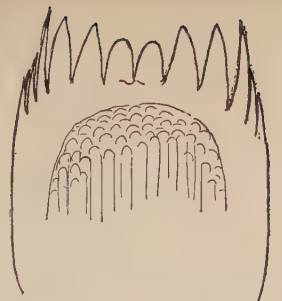

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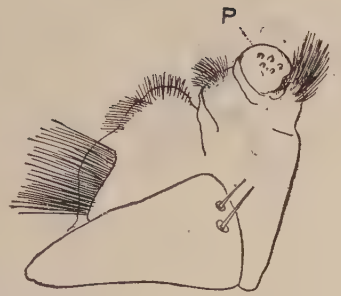


127

126

125

122

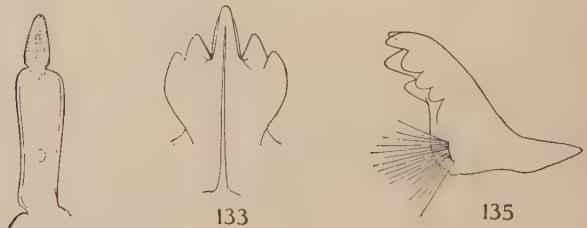
RHIPIDIA BRYANTI, LARVA

121, Labrum-epipharynx; 122, mentum; 123 and 124, hypopharynx; 125, antenna; 126, mandible; 127, maxilla

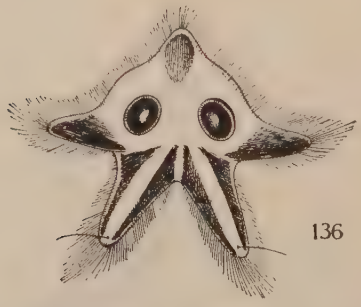
128

129 130 131

132



134 133 135



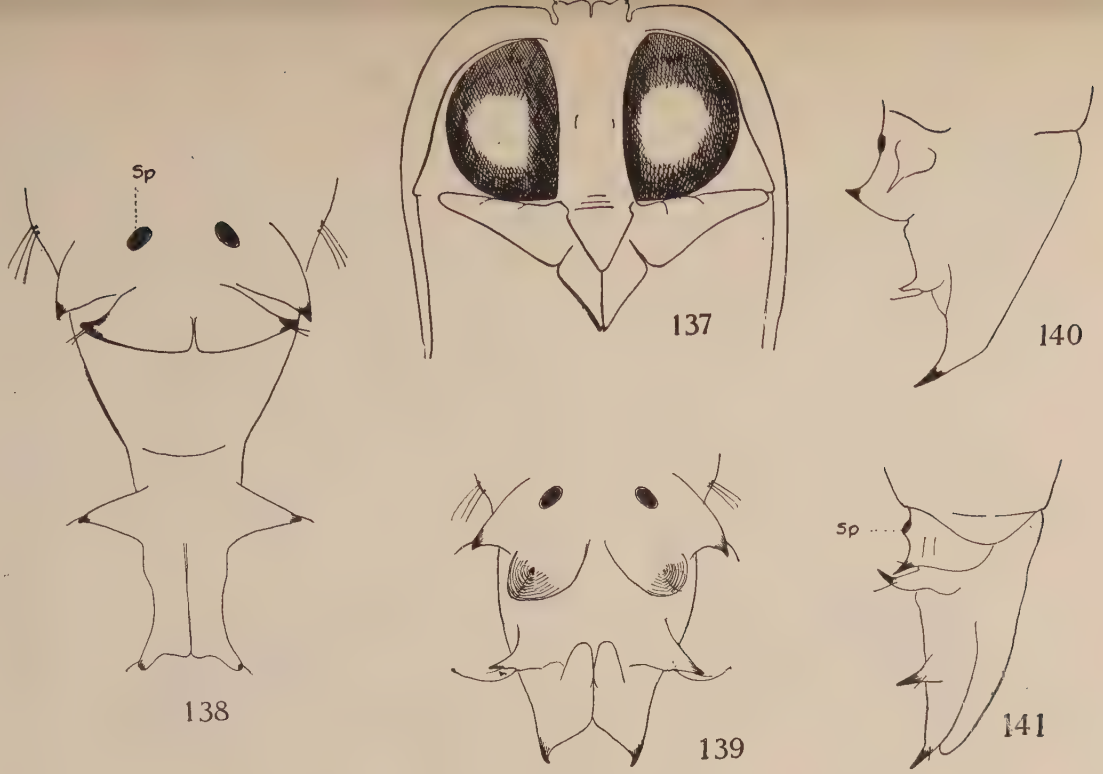
136

RHIPIDIA BRYANTI, RHAMPHIDIA MAINENSIS, AND RHAMPHIDIA FLAVIPES

Rhipidia bryanti, pupa: 128, mouth parts; 129, pronotal breathing horn; 130, male cauda, lateral aspect; 131, male cauda, dorsal aspect

Rhamphidia mainensis, larva: 132, lateral aspect; 133, mentum; 135, mandible; 136, spiracular disk

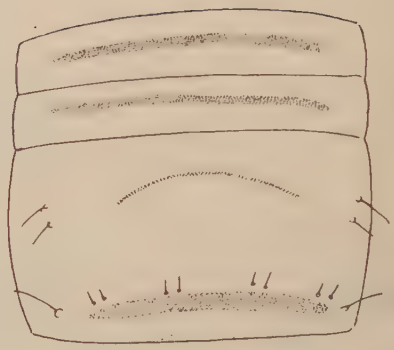
Rhamphidia flavipes, larva: 134, antenna



RHAMPHIDIA FLAVIPES, PUPA

137, Head of male, ventral aspect; 138, female cauda, dorsal aspect; 139, male cauda, dorsal aspect; 140, male cauda, lateral aspect; 141, female cauda, lateral aspect

142



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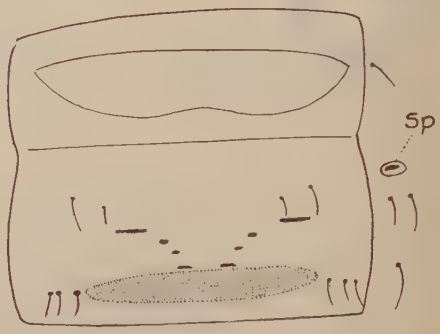
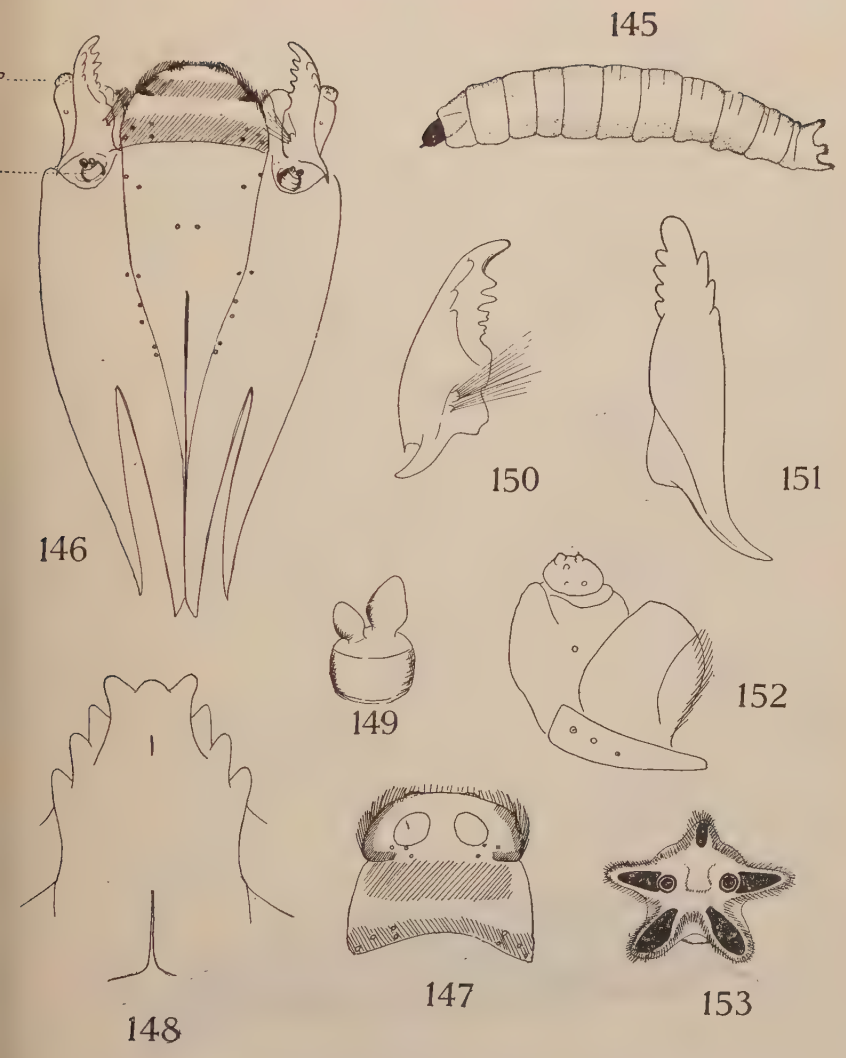


144

RHAMPHIDIA FLAVIPES, PUPA

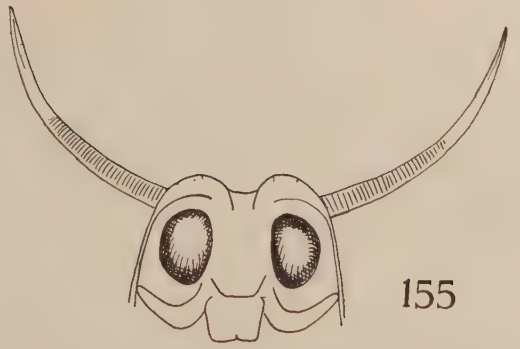
142, Lateral aspect; 143, fifth abdominal segment, dorsal aspect (diagrammatic); 144 fifth abdominal segment, ventral aspect (diagrammatic)



ULA ELEGANS, LARVA

5, Lateral aspect; 146, head capsule, dorsal aspect; 147, labrum-epipharynx; 148, mentum
antenna; 150, mandible, lateral aspect; 151, mandible, from inside; 152, maxilla; 153,
cular disk

154



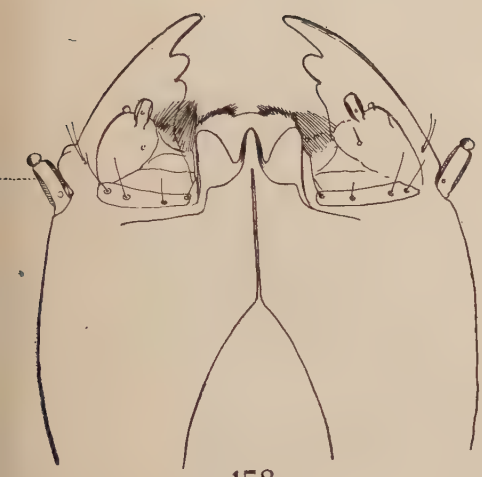
155

156

157

ULA ELEGANS, PUPA

154, Female, lateral aspect; 155, head, ventral aspect; 156, female cauda, dorsal aspect; 157, male



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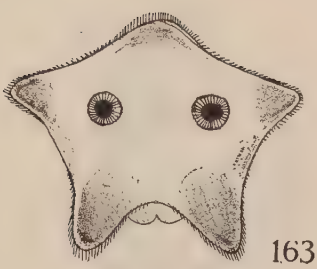

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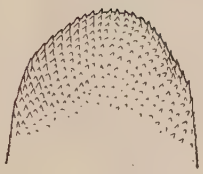

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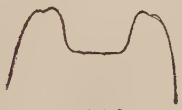

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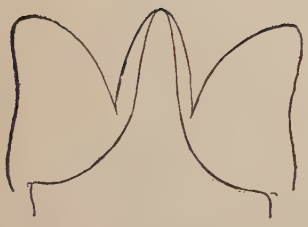

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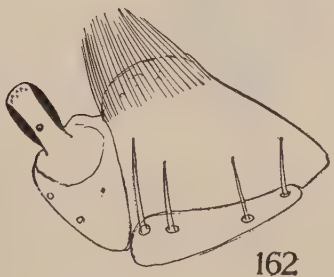


162

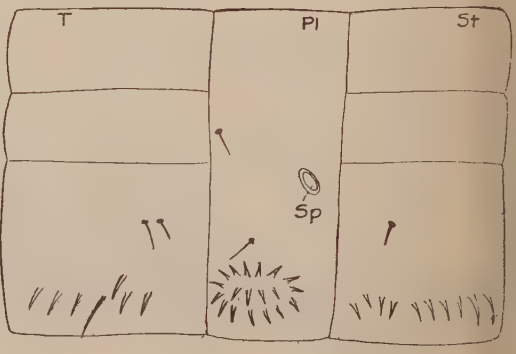
EPIPHRAGMA SOLATRIX, LARVA

8, Head capsule, ventral aspect; 159, mentum; 160, prementum; 161, hypopharynx; 162, maxilla; 163, spiracular disk

164

166

165

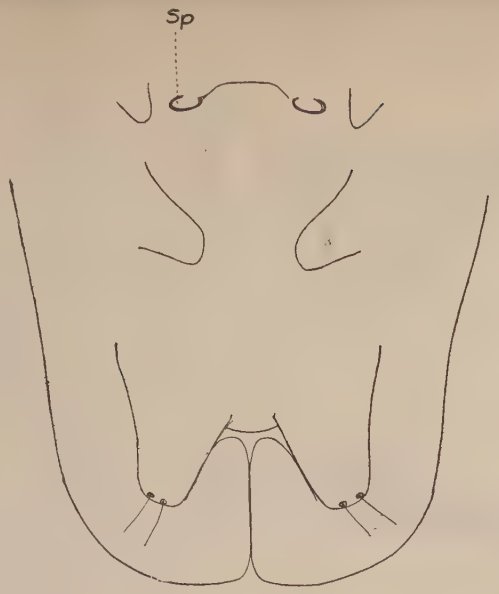


167

EPIPHRAGMA SOLATRIX AND E. FASCIPENNIS

Epiphragma solatrix, pupa: 164, lateral aspect; 166, head of male, ventral aspect; 167, fifth abdominal segment (diagrammatic)

Epiphragma fascipennis, pupa: 165, cephalic crest, lateral aspect



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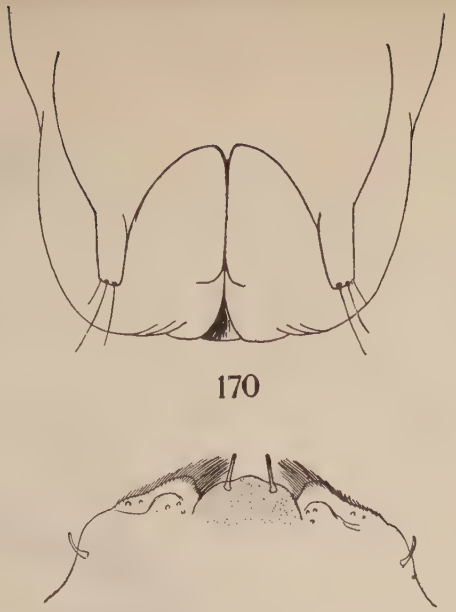

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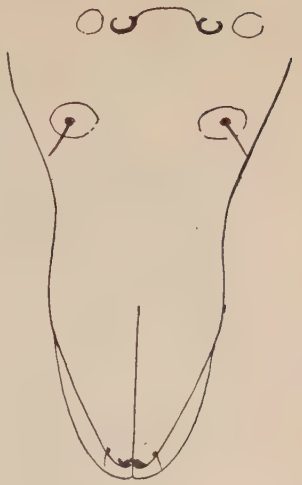
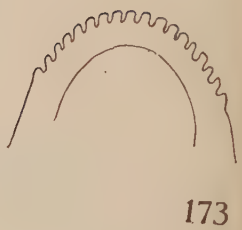


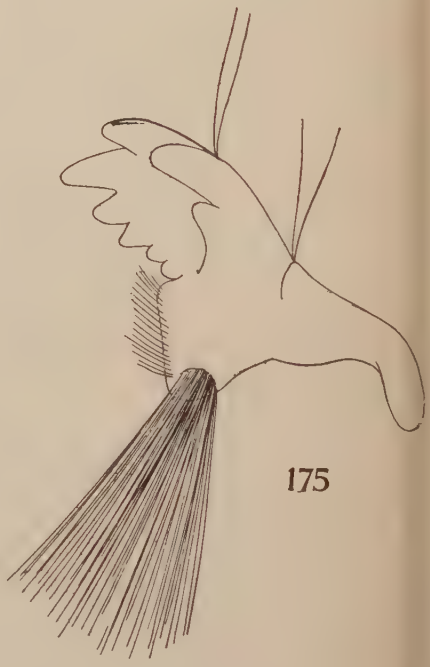
171

1069

EPIPHRAGMA FASCIPENNIS AND E. SOLATRIX

Epiphragma fascipennis: 168, larva, labrum; 169, pupa, male cauda, dorsal aspect
Epiphragma solatrix, pupa: 170, male cauda, dorsal aspect; 171, female cauda, dorsal aspect

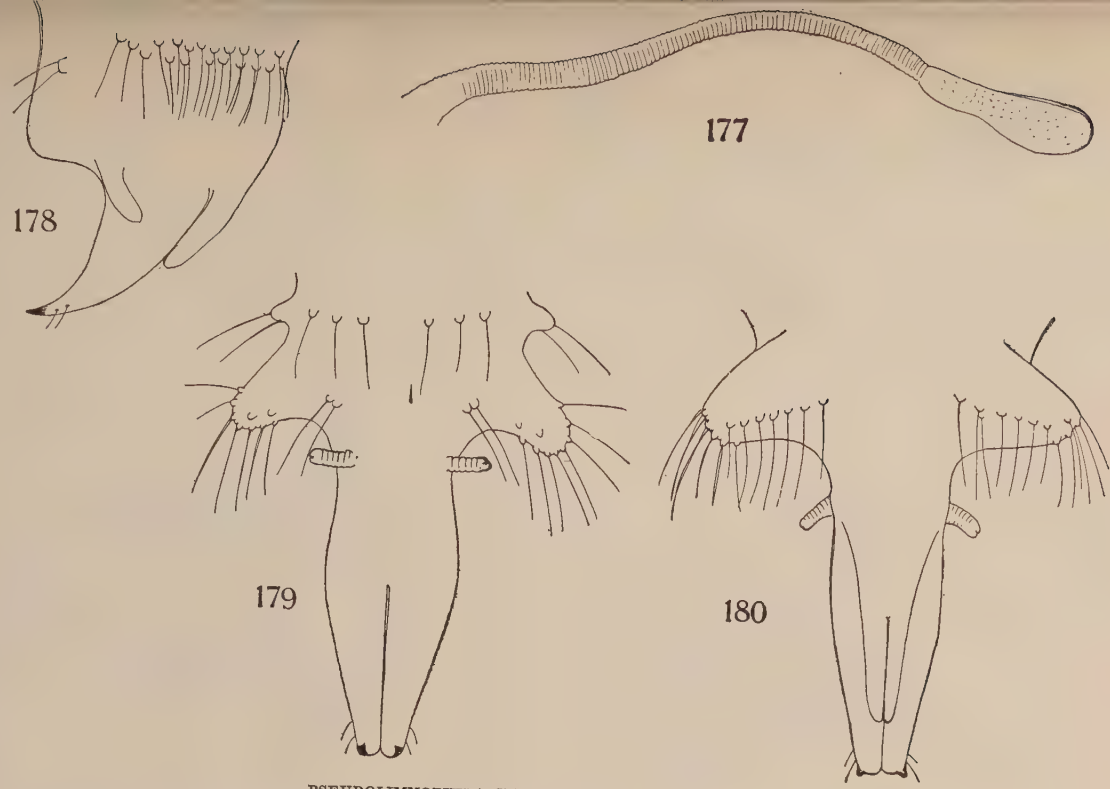




PSEUDOLIMNOPHILA LUTEIPENNIS AND P. INORNATA

Pseudolimnophila luteipennis, larva: 172, mentum; 173, hypopharynx; 175, mandible; 176, spiracular disk

Pseudolimnophila inornata, larva: 174, antenna



PSEUDOLIMNOPHILA INORNATA AND P. LUTEIPENNIS

Pseudolimnophila inornata, pupa: 177, pronotal breathing horn
Pseudolimnophila luteipennis, pupa: 178, male cauda, lateral aspect; 179, female cauda, dorsal aspect; 180, female cauda, ventral aspect

184

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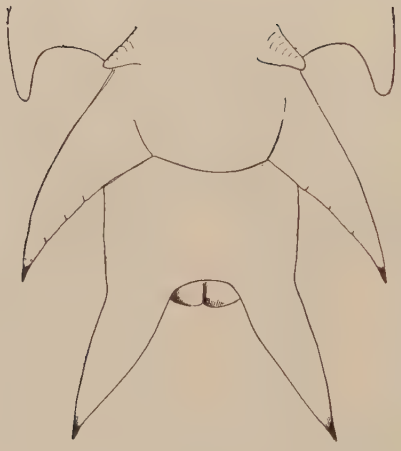
186

183

182

181



189

187

188

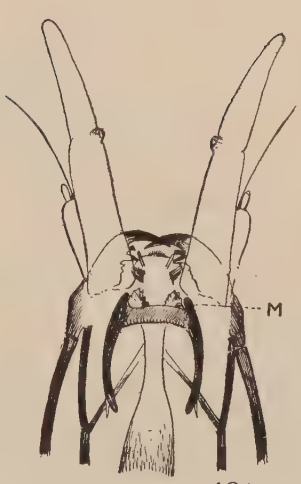
DACTYLOLABIS DENTICULATA, D. WODZICKII, AND D. CUBITALIS

Dactylolabis denticulata (after Mik): 181, pupa; 182, larva, head capsule, ventral aspe
183, larva, dorsal aspect

Dactylolabis wodzickii (after Nowicki): 184, pupa; 185, larva, head capsule; 186, lar
spiracular disk

Dactylolabis cubitalis, pupa: 187, pronotal breathing horn; 188, second abdominal s
ment, showing spiracle; 189, male cauda, dorsal aspect

193



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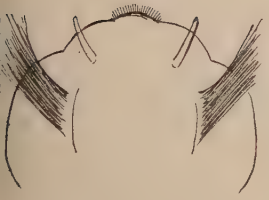
194



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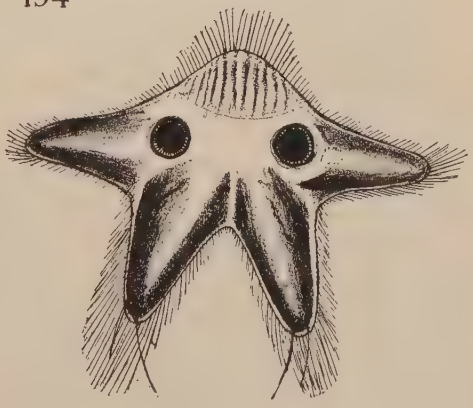
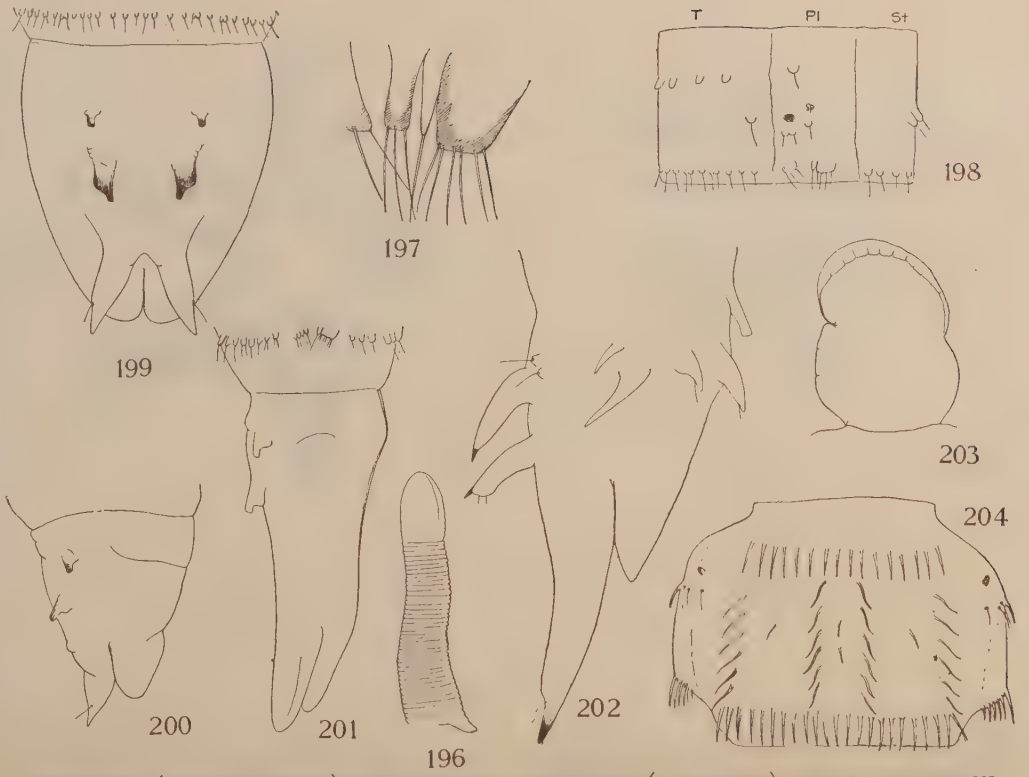


195

LIMNOPHILA (DICRANOPHRAGMA) FUSCOVARIA, LARVA

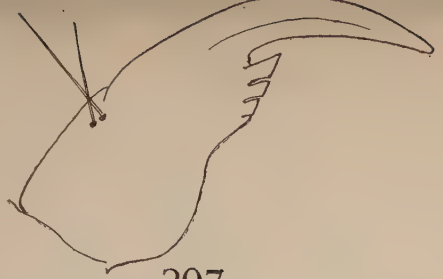
0, Cephalic and caudal ends, dorsal aspect; 191, head capsule, ventral aspect; 192, labrum epipharynx; 193, antenna; 194, mandible; 195, spiracular disk



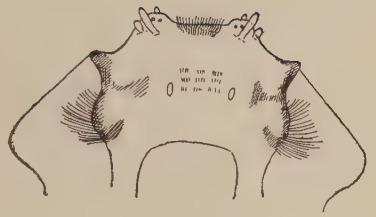
LIMNOPHILA (DICRANOPHRAGMA) FUSCOVARIA AND LIMNOPHILA (PHYLIDOREA) ADUSTA, SUPPOSITION

Limnophila (*Dicranophragma*) *fuscovaria*, pupa: 196, pronotal breathing horn; 197, pleural abdominal spines; 198, fifth abdominal segment (diagrammatic); 199, male cauda, dorsal aspect; 200, male cauda, lateral aspect; 201, female cauda, lateral aspect

Limnophila (*Phylidorea*) *adusta* (pupa): pupa; 202, female cauda, lateral aspect; 203, pronotal



207



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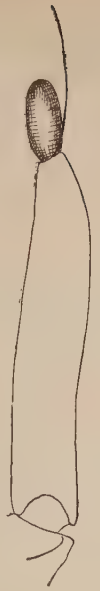


206

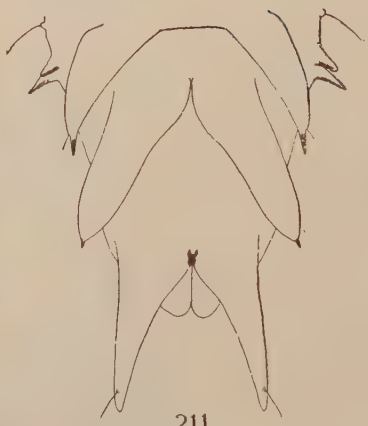
208

LIMNOPHILA (LASIOMASTIX) MACROCERA, LARVA

205, Labrum; 206, antenna; 207, mandible; 208, spiracular disk, dorsal aspect

209

210

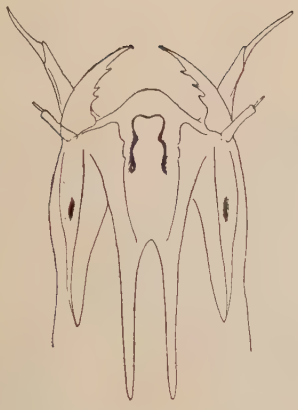


211

212

LIMNOPHILA (LASIOMASTIX) MACROCERA, PUPA

209, Male, lateral aspect; 210, mouth parts; 211, male cauda, dorsal aspect; 212, fem
cauda, lateral aspect



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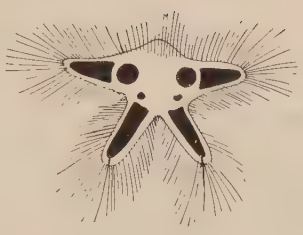

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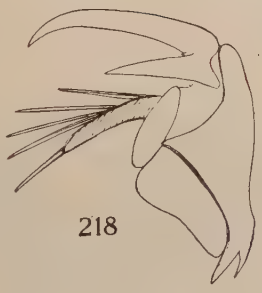


218

217

219

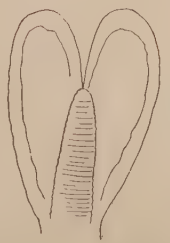
LIMNOPHILA PICTIPENNIS, L. PUNCTATA, AND ULOMORPHA PILOSELLA

Limnophila pictipennis: 213, head capsule (after Brauer)
Limnophila punctata: 214, spiracular disk (after Gerbig)
Ulomorpha pilosella, larva: 215, head capsule, dorsal aspect; 216, labrum; 217, antenna; 218, mandible; 219, spiracular disk, dorsal aspect

220

221

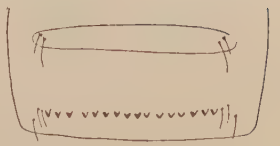
222



223

226

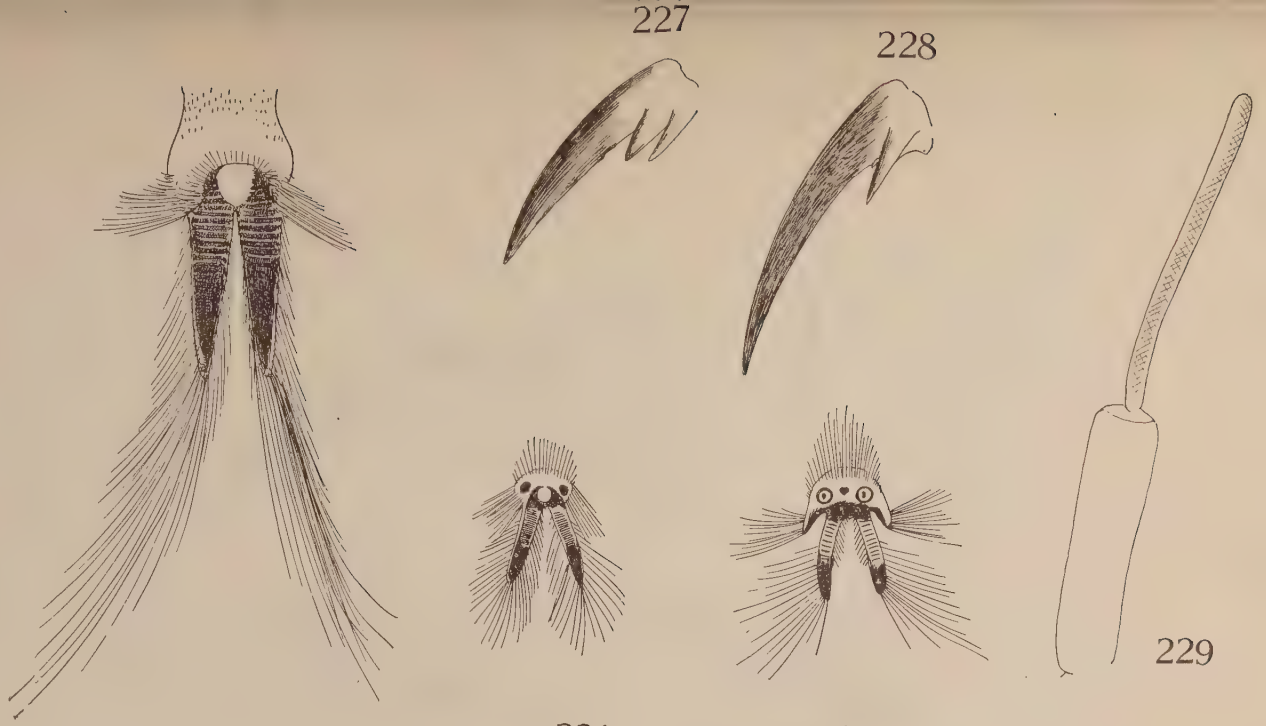
224



225

ULOMORPHA PILOSELLA, PUPA

220, Female, lateral aspect; 221, mouth parts; 222, apex of breathing horn; 223, apex of breathing horn viewed from beneath; 224, fifth abdominal [illegible]



PILARIA RECONDITA, P. TENUIPES, P. FUSCIPENNIS, AND P. DISCICOLLIS

Pilaria recondita, larva: 227, tip of mandible
Pilaria tenuipes, larva: 228, tip of mandible; 229, antenna; 230, spiracular disk, dorsal aspect
Pilaria fuscipennis: 231, spiracular disk (after Gerbig)
Pilaria discicollis: 232, spiracular disk (after Gerbig)

233

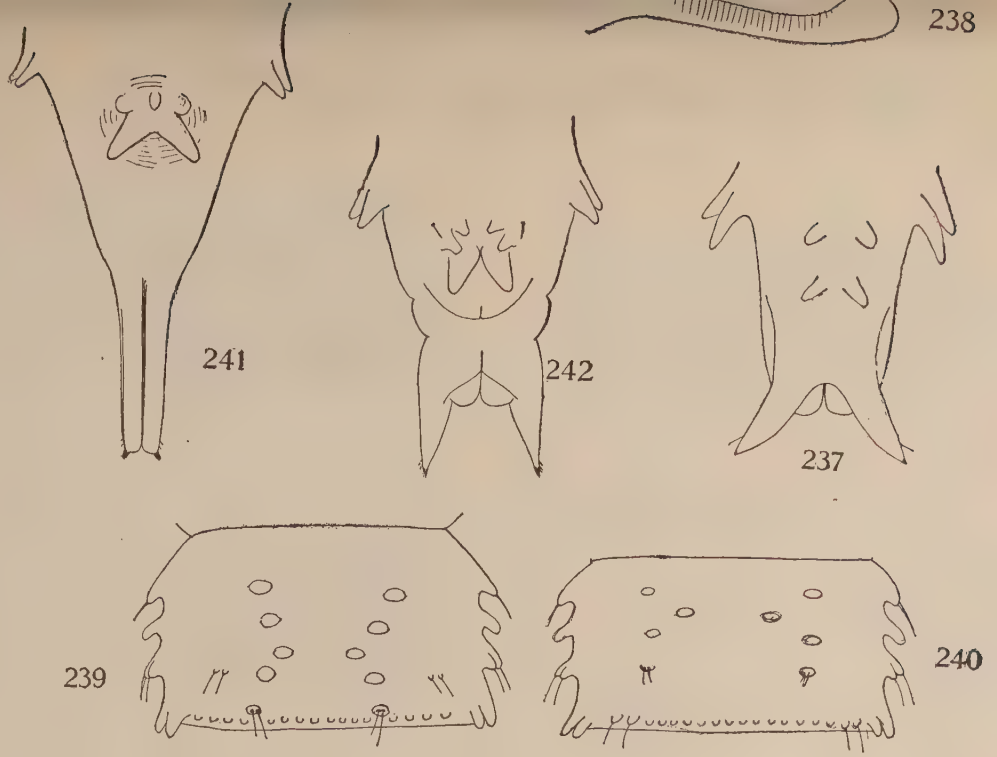
235

234

236

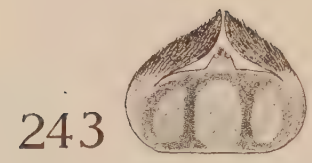
PILARIA TENUIPES, PUPA

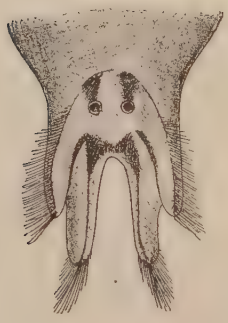
233, Female, lateral aspect; 234, female cauda, lateral aspect; 235, fifth abdominal segment dorsal aspect; 236, female cauda, dorsal aspect



PILARIA RECONDITA AND P. QUADRATA

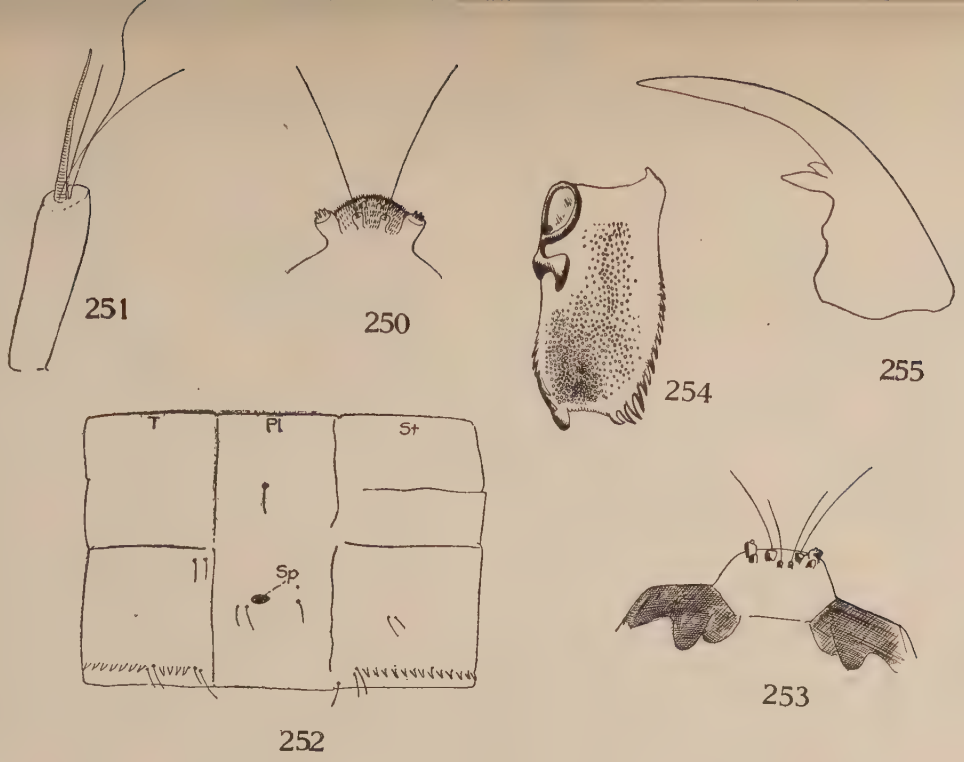
Pilaria recondita, pupa: 237, male cauda, dorsal aspect
Pilaria quadrata, pupa: 238, pronotal breathing horn; 239, fifth abdominal segment, dorsal aspect; 240, fifth abdominal segment, ventral aspect; 241, female cauda, dorsal aspect; 242, male cauda, dorsal aspect





HEXATOMA MEGACERA

Larva: 243, labrum; 244, antenna; 245, mandible; 246, spiracular disk
Pupa: 247, lateral aspect; 248, male, ventral aspect; 249, female, ventral aspect



HEXATOMA MEGACERA AND ERIOCERA CINEREA

Hexatoma megacera: 250, larva, apex of labrum; 251, larva, antenna; 252, pupa, fifth abdominal segment, lateral aspect

Eriocera cinerea, larva: 253, labrum; 254, pharyngeal plate; 255, mandible

256

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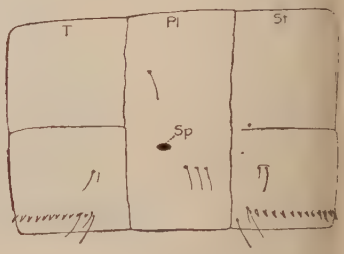

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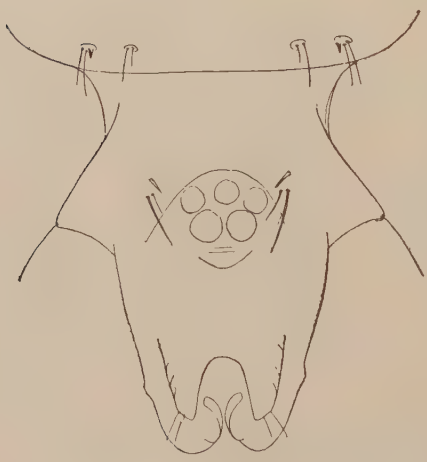

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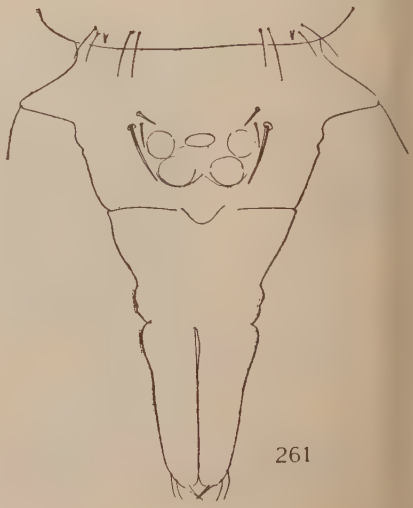
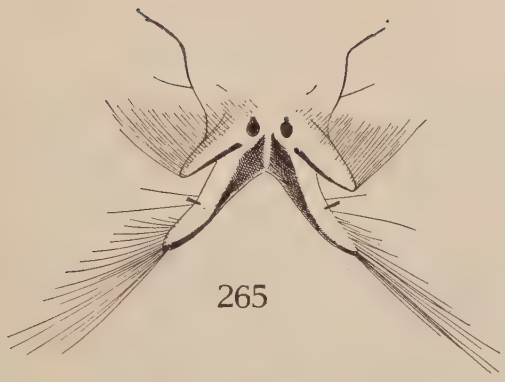
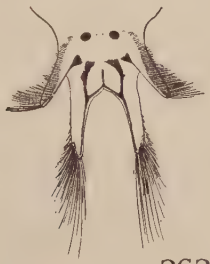


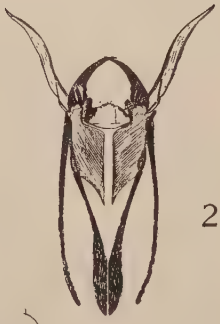
261

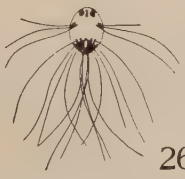
ERIOCERA CINEREA, PUPA

256, Male, lateral aspect; 257, cephalic crest of male, ventral aspect; 258, mouth parts; 259, fifth abdominal segment, lateral aspect; 260, male cauda, dorsal aspect; 261, female cauda, dorsal aspect



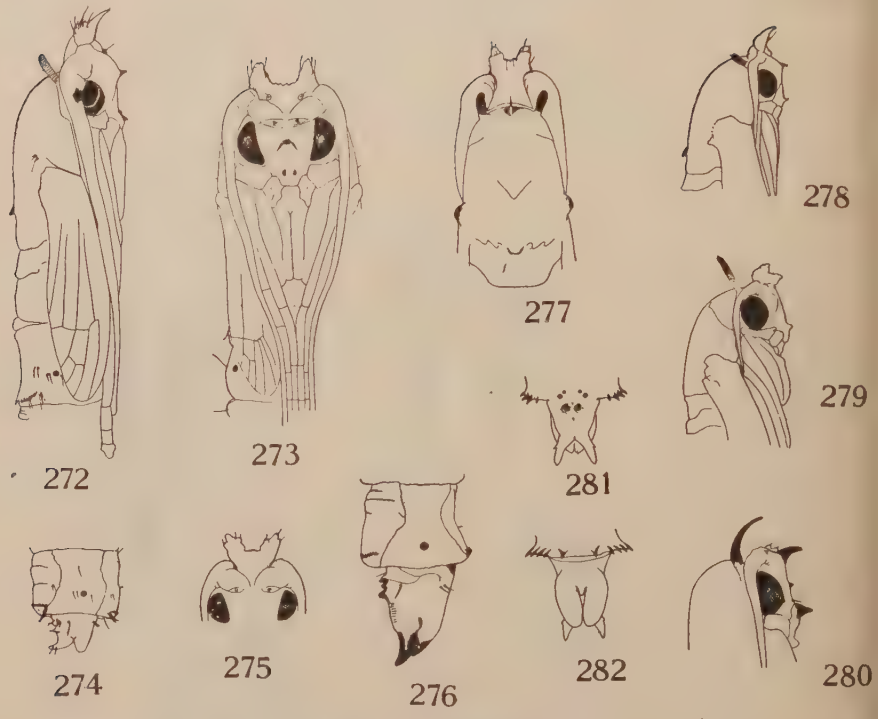






ERIOCERA SPINOSA, E. CINEREA, E. LONGICORNIS, AND E. FULTONENSIS

Eriocera spinosa, larva: 262, spiracular disk; 267, head capsule, dorsal aspect; 271, mandible
Eriocera cinerea, larva: 263 and 264, spiracular disk; 270, mandible
Eriocera longicornis, larva: 265, spiracular disk
Eriocera fultonensis, larva: 266, spiracular disk; 268, labrum; 269, mandible

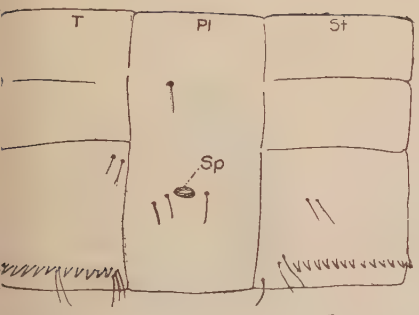


ERIOCERA LONGICORNIS, E. FULTONENSIS, AND E. SPINOSA

Eriocera longicornis, pupa: 272, male, lateral aspect; 273, male, ventral aspect; 274, female cauda, lateral aspect; 275, head of male, ventral aspect; 277, thorax of male, dorsal aspect; 278, female, lateral aspect

Eriocera fultonensis, pupa: 276, female cauda, lateral aspect; 279, female, lateral aspect

Eriocera spinosa, pupa: 280, female, lateral aspect; 281, male cauda, dorsal aspect; 282, male cauda, ventral aspect



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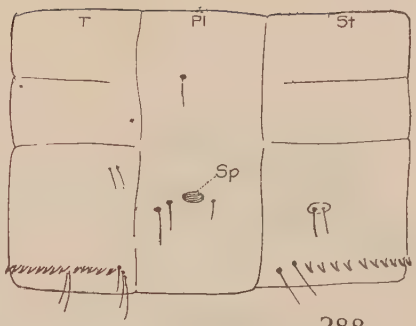

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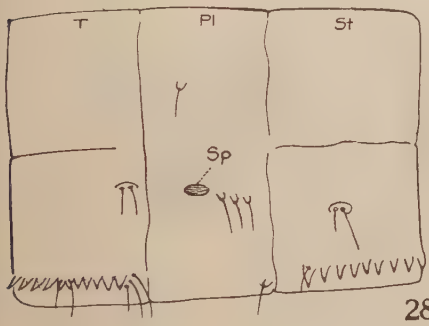

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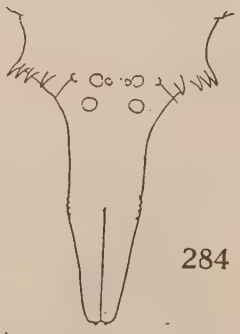

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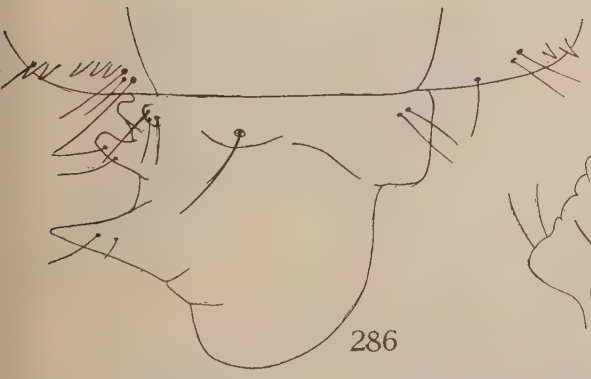

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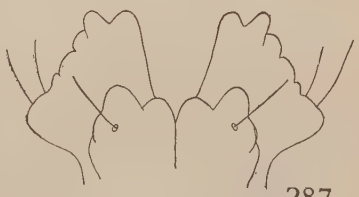


287

ERIOCERA SPINOSA, E. LONGICORNIS, AND E. FULTONENSIS

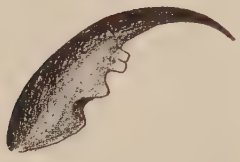
Eriocera spinosa, pupa: 283, fifth abdominal segment, lateral aspect (diagrammatic); 4, female cauda, dorsal aspect

Eriocera longicornis, pupa: 285, fifth abdominal segment, lateral aspect (diagrammatic); 6, male cauda, lateral aspect

Eriocera fultonensis, pupa: 287, cephalic crest of male, ventral aspect; 288, fifth abdominal gment, lateral aspect (diagrammatic)

289

294



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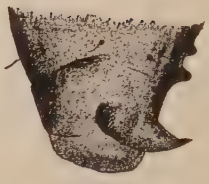

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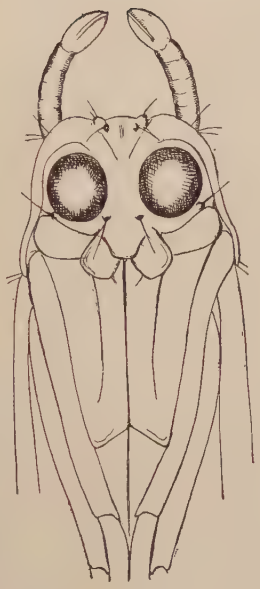
293

PENTHOPTERA ALBITARSIS

Larva: 289, labrum; 290, antenna; 291, mandible; 292, spiracular disk, dorsal aspect; 293, spiracular disk, lateral aspect

Pupa: 294, pronotal breathing horn; 295, male cauda, lateral aspect

296



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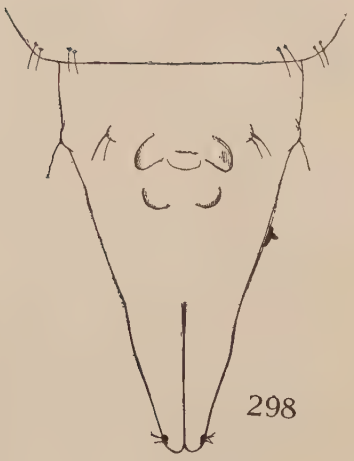

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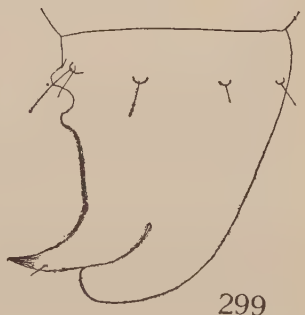
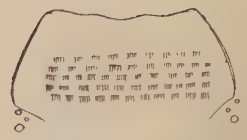


299

PENTHOPTERA ALBITARSIS, PUPA

296, Female, lateral aspect; 297, female, ventral aspect; 298, female cauda, dorsal aspect; 299, male cauda, lateral aspect



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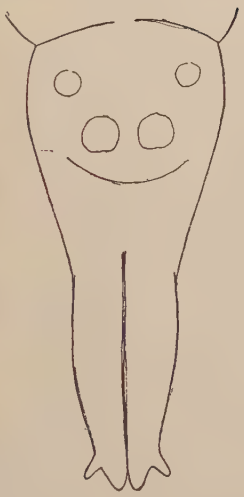
305

ADELPHOMYIA MINUTA (SUPPOSITION), LARVA

300, Labrum; 301, antenna; 302, mentum; 303, mandible; 304, maxilla; 305, spiracular disk

307

309



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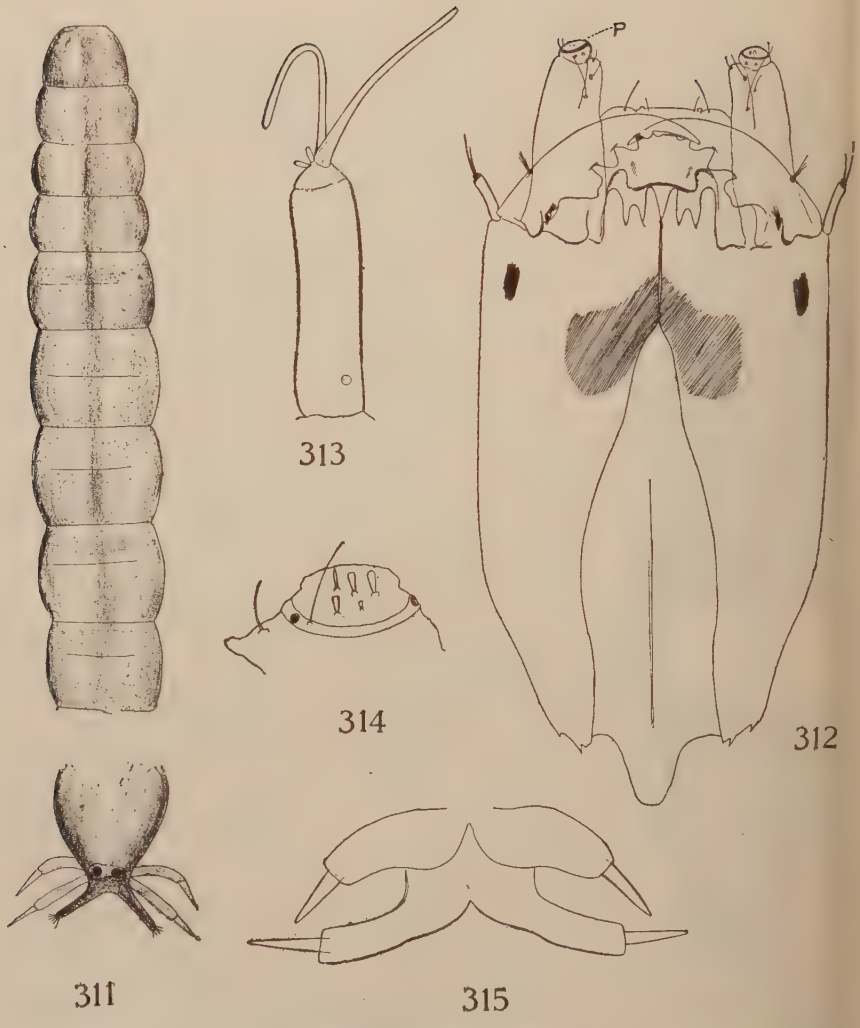
310

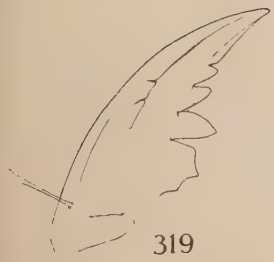
ADELPHOMYIA MINUTA (SUPPOSITION), PUPA

6, Female, lateral aspect; 307, mouth parts; 308, female cauda, dorsal aspect; 309, male cauda, dorsal aspect; 310, male cauda, lateral aspect



PEDICIA ALBIVITTA, LARVA

311, Dorsal aspect; 312, head capsule, ventral aspect; 313, antenna; 314, maxillary palpus; 315, anal gills, ventral aspect



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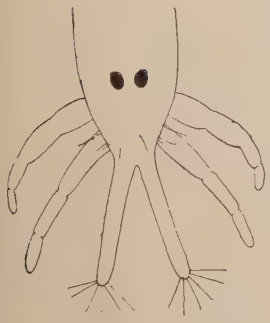

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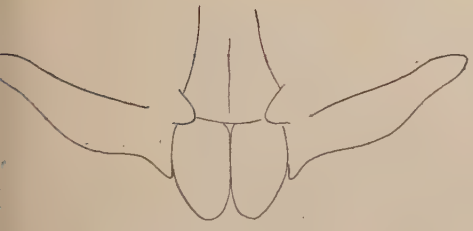

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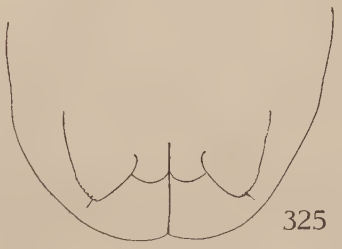
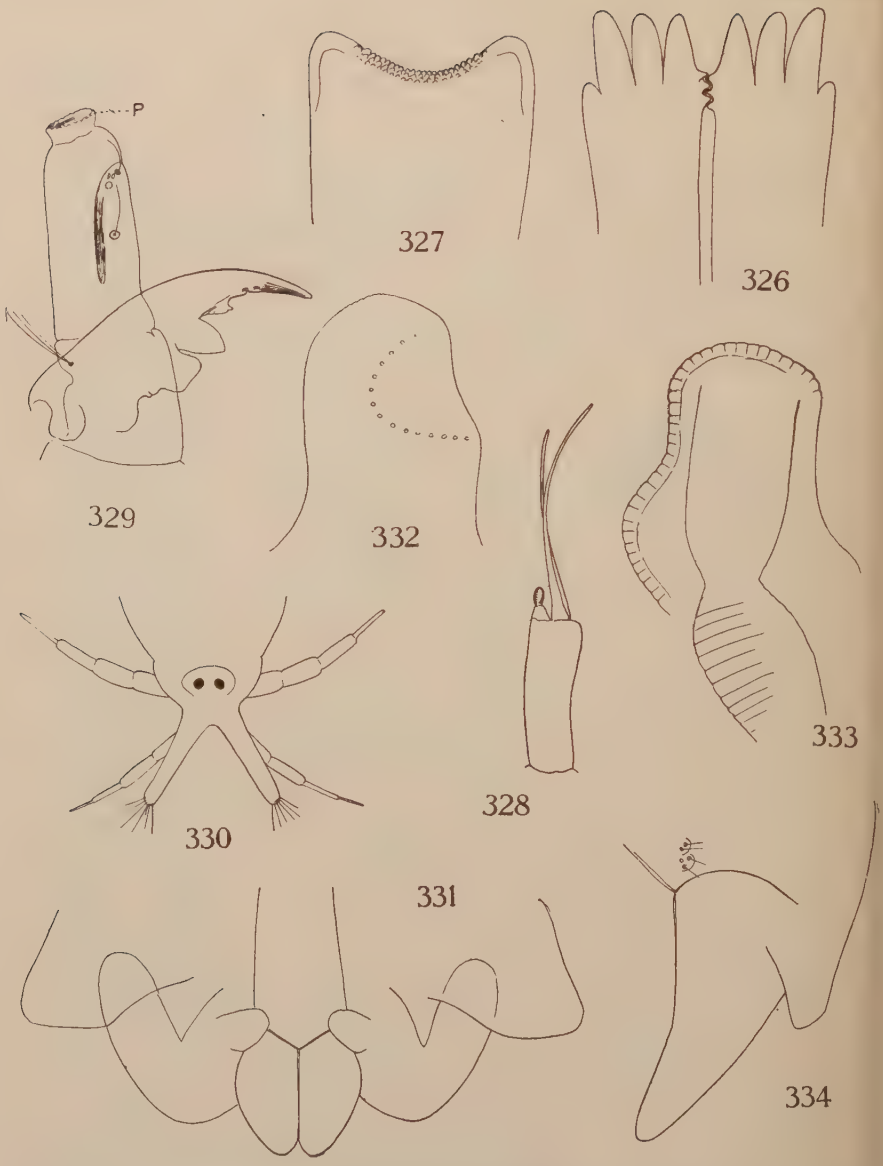


325

RHAPHIDOLABINA FLAVEOLA

Larva: 316, mentum; 317, hypopharynx; 318, antenna; 319, mandible; 320, maxilla; 1, spiracular disk

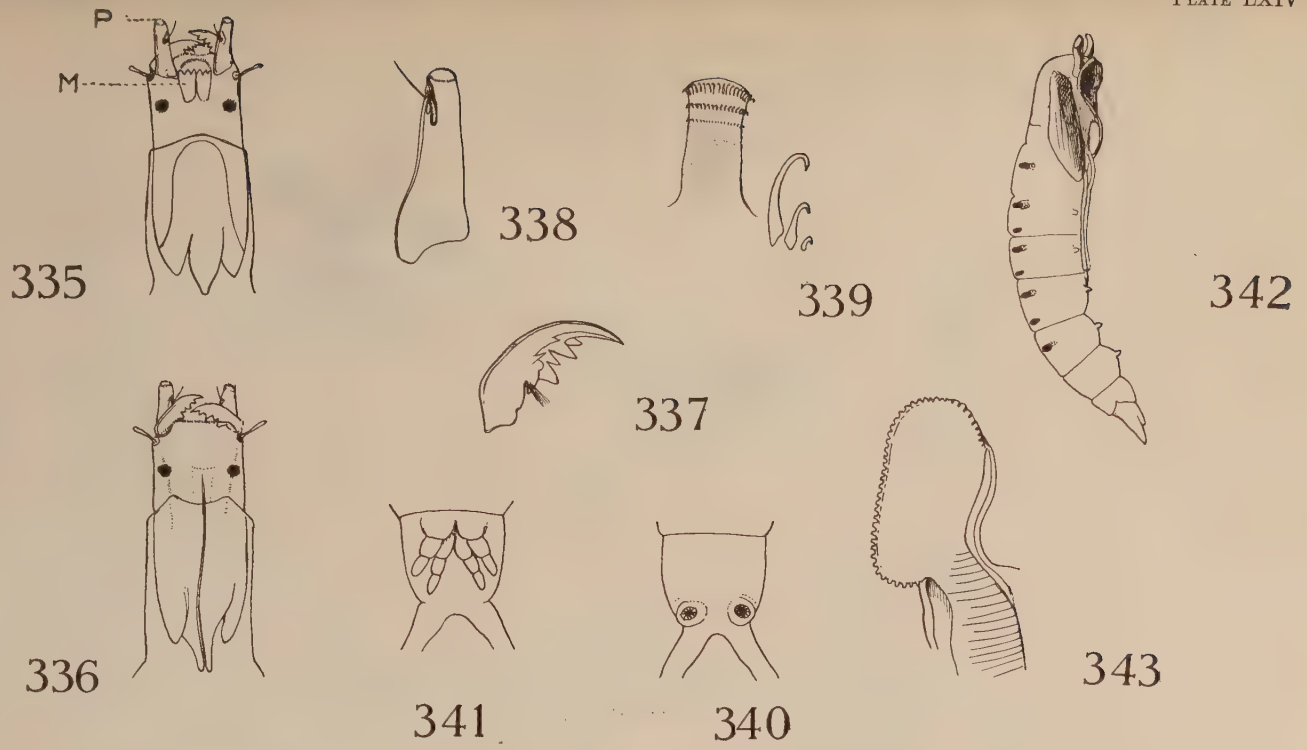
Pupa: 322, mouth parts; 323, pronotal breathing horn, dorsal aspect; 324, pronotal eathing horn, lateral aspect; 325, male cauda, dorsal aspect



TRICYPHONA INCONSTANS

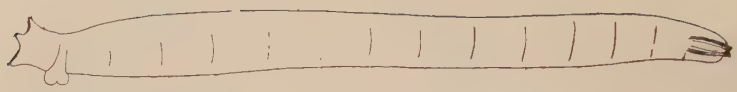
Larva: 326, mentum; 327, hypopharynx; 328, antenna; 329, mandible and maxilla; 330, spiracular disk

Pupa: 331, mouth parts; 332, pronotal breathing horn, dorsal aspect; 333, pronotal breathing horn, lateral aspect; 334, female cauda, lateral aspect



DICRANOTA BIMACULATA (AFTER MIALL)

Larva: 335, head capsule, ventral aspect; 336, head capsule, dorsal aspect; 337, mandible; 338, maxillary palpus; 339, abdominal pseudopods; 340, spiracular disk, dorsal aspect; 341, anal gills
Pupa: 342, female, lateral aspect; 343, pronotal breathing horn



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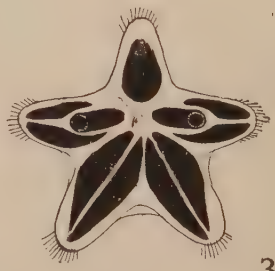

351

MOLOPHILUS HIRTIPENNIS, LARVA

344, Lateral aspect; 345, head capsule, ventral aspect; 346, mental plate; 347, hypopharynx; 348, antenna; 349, mandible; 350, maxilla; 351, spiracular disk

352

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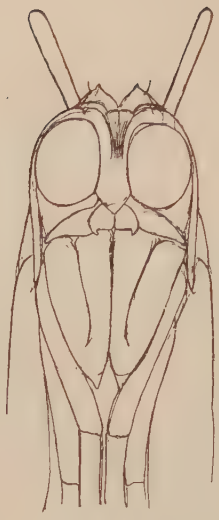
MOLOPHILUS HIRTIPENNIS, PUPA

52, Female, lateral aspect; 353, male cauda, lateral aspect; 354, male cauda, dorsal aspect; 355, female cauda, lateral aspect; 356, female cauda, dorsal aspect

359



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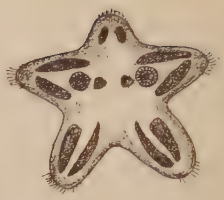

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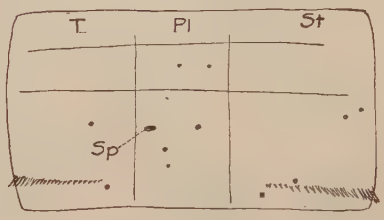

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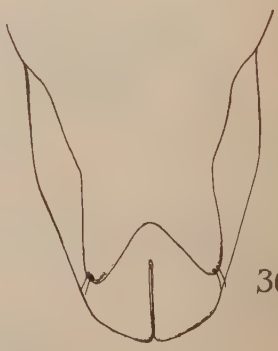
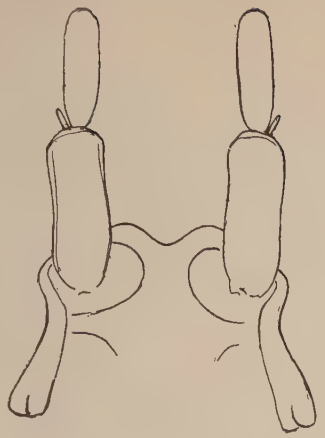


363

ERIOPTERA MEGOPHTHALMA

Larva: 357, spiracular disk; 358, anal gills, ventral aspect

Pupa: 359, female, lateral aspect; 360, female, ventral aspect; 361, fifth abdominal segment, lateral aspect (diagrammatic); 362, male cauda, lateral aspect; 363, male cauda, dorsal aspect



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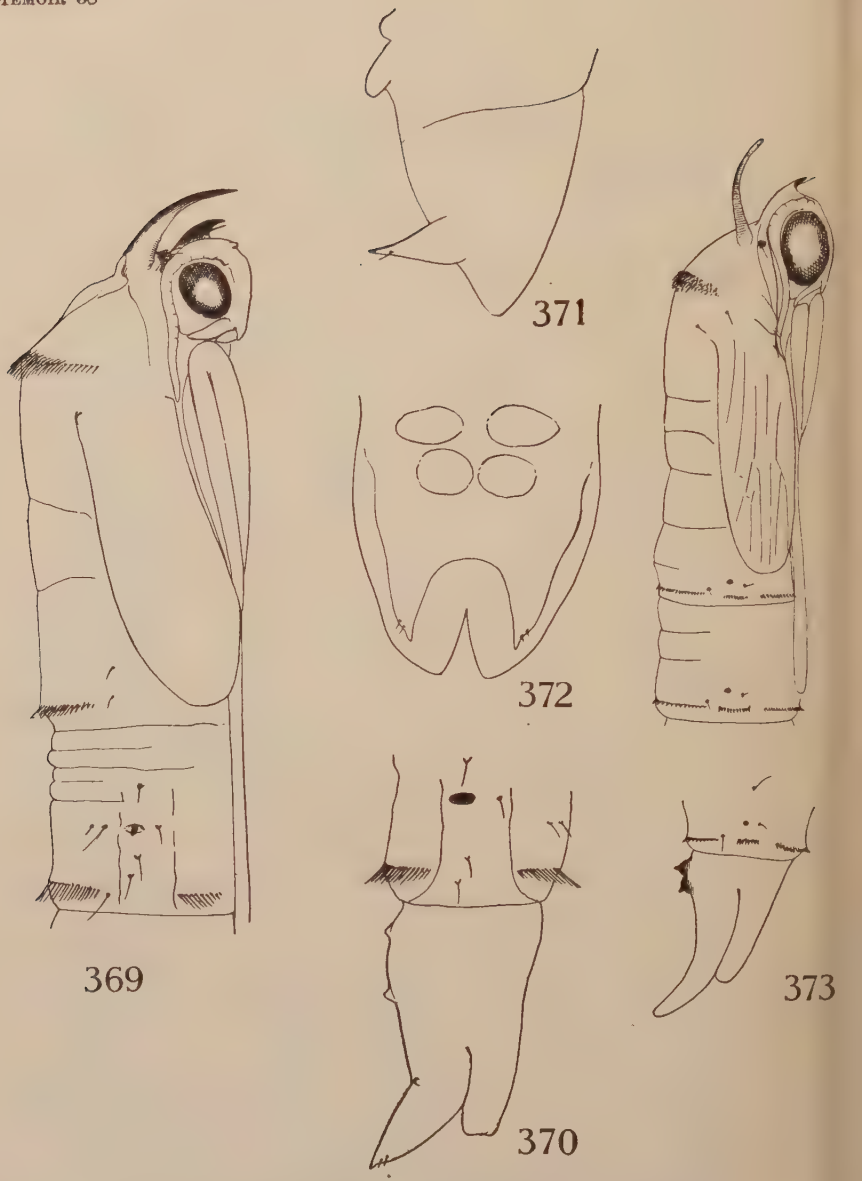
ERIOPTERA CHLOROPHYLLA, LARVA

364, Head capsule, showing bases of antennae; 365, mental bar; 366, aberration of mental bar; 367, antenna; 368, mandible



ERIOPTERA CHLOROPHYLLA, E. SEPTEMTRIONIS, AND E. ARMATA

Erioptera chlorophylla, pupa: 369, female, lateral aspect; 370, female cauda, lateral aspect
Erioptera septemtrionis, pupa: 371, male cauda, lateral aspect; 372, male cauda, dorsal aspect
Erioptera armata, pupa: 373, female, lateral aspect

375

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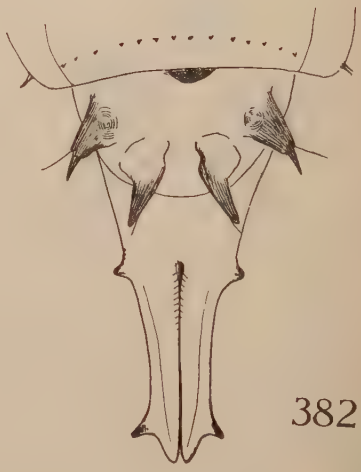
378

ORMOSIA NUBILA, O. INNOCENS, AND O. MEIGENII

Ormosia nubila, larva: 374, mandible; 375, spiracular disk
Ormosia innocens, pupa: 376, female, lateral aspect; 377, male cauda, dorsal aspect; 378, male cauda, lateral aspect
Ormosia meigenii, larva: 379, spiracular disk

380

381

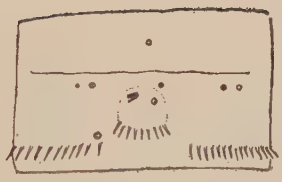


382

ORMOSIA NUBILA, PUPA

380, Female, lateral aspect; 381, cephalic crest of female, ventral aspect; 382, female cauda, dorsal aspect

383



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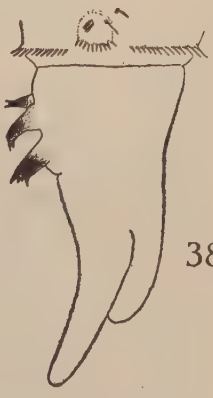
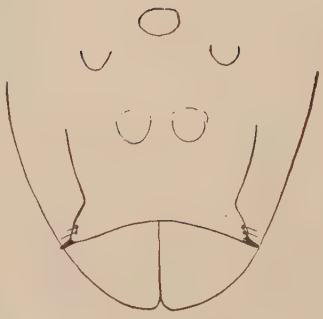
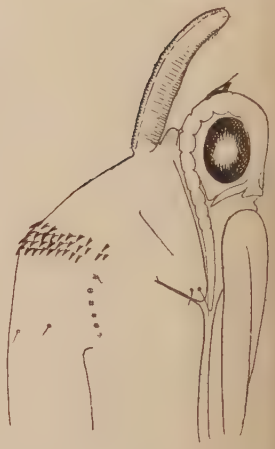


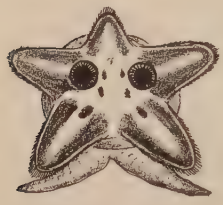
387

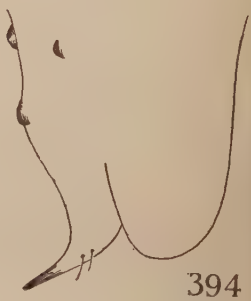
ORMOSIA NIGRIPILA, PUPA

383, Male, lateral aspect; 384, pronotal breathing horn; 385, fifth abdominal segment, lateral aspect (diagrammatic); 386, male cauda, dorsal aspect; 387, female cauda, lateral aspect







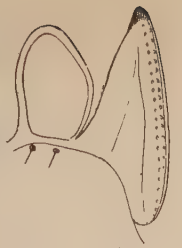


HELOBIA HYBRIDA AND TRIMICRA PILIPES

Helobia hybrida, larva: 388, spiracular disk
Helobia hybrida, pupa: 389, female, lateral aspect; 390, mouth parts; 391, arrangement of leg sheaths; 392, male cauda, dorsal aspect; 393, female cauda, lateral aspect; 394, male cauda, lateral aspect
Trimicra pilipes, larva: 395, spiracular disk (after Gerbig)

396

399



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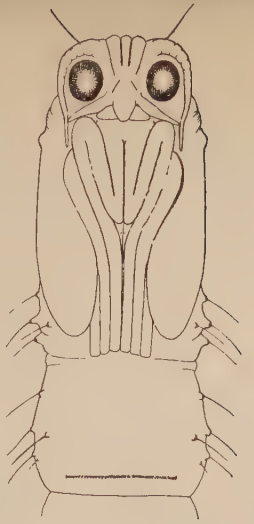

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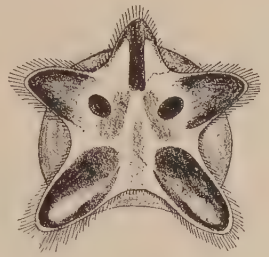

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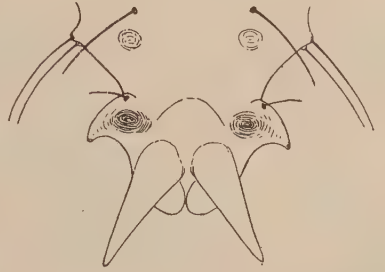
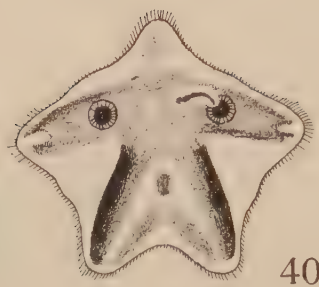


401

GNOPHOMYIA TRISTISSIMA

Larva: 396, head capsule (after Malloch); 397, spiracular disk (after Malloch)
Pupa: 398, female, ventral aspect; 399, pronotal breathing horn, lateral aspect; 400, pronotal breathing horn and thoracic crest, dorsal aspect; 401, male cauda, dorsal aspect



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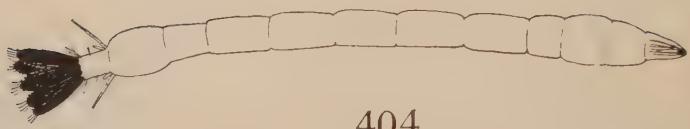

404

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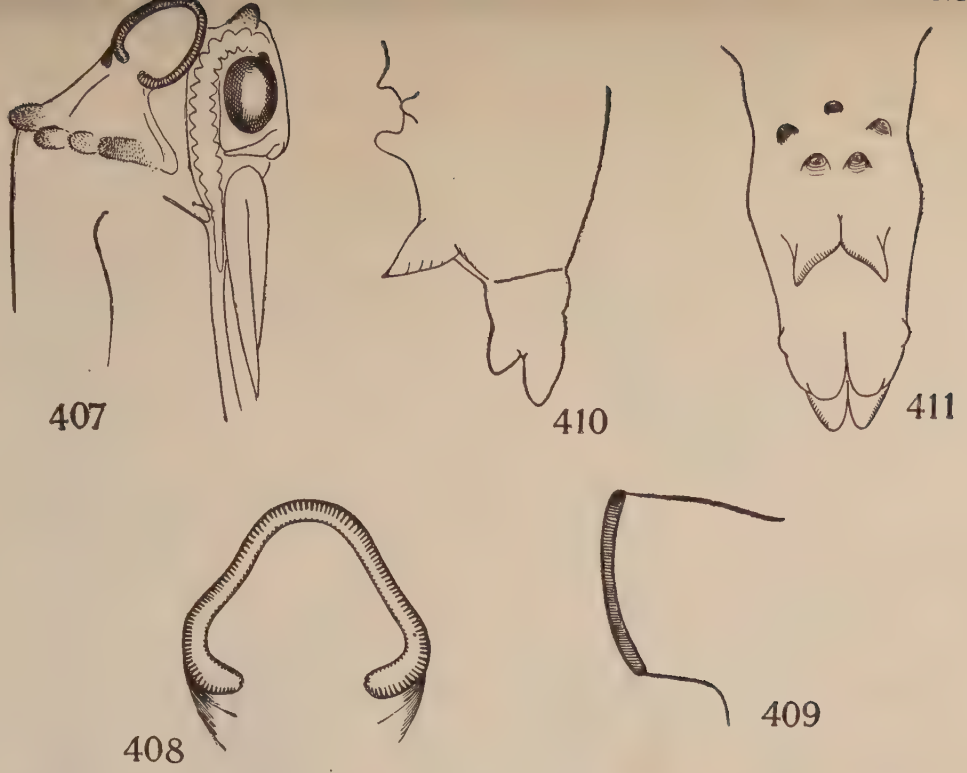
405

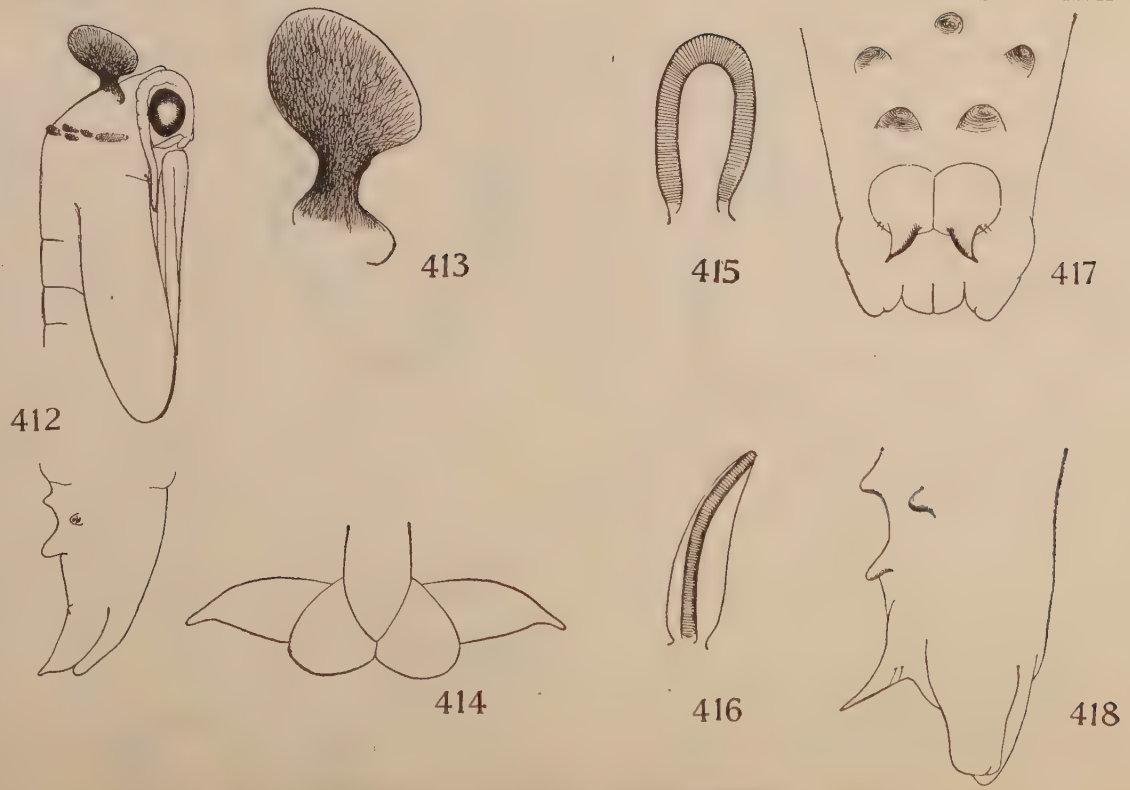
GONOMYIA ALEXANDERI AND ERIOPTERINE NO. 1

Gonomyia alexanderi, larva: 402, mandible; 403, spiracular disk
Eriopterine No. 1, larva: 404, lateral aspect; 405, spiracular disk and anal gills; 406, lobe of spiracular disk, enlarged



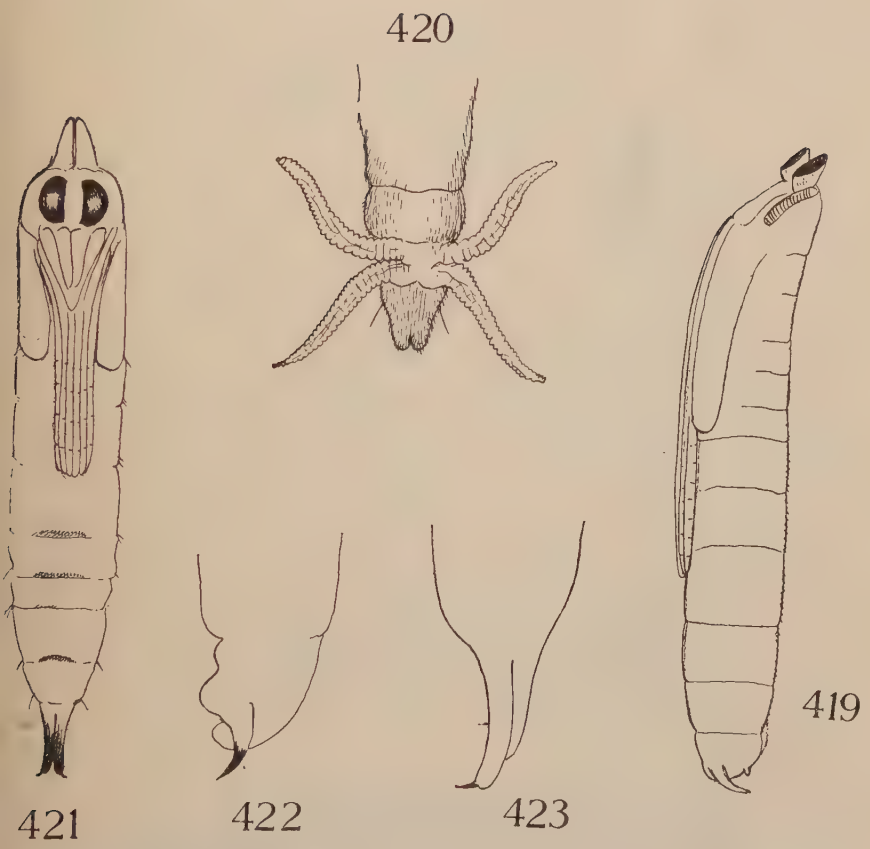
GONOMYIA ALEXANDERI, PUPA

407, Male, lateral aspect; 408, pronotal breathing horn; 409, pronotal breathing horn, lateral aspect; 410, male cauda, lateral aspect; 411, male cauda, dorsal aspect



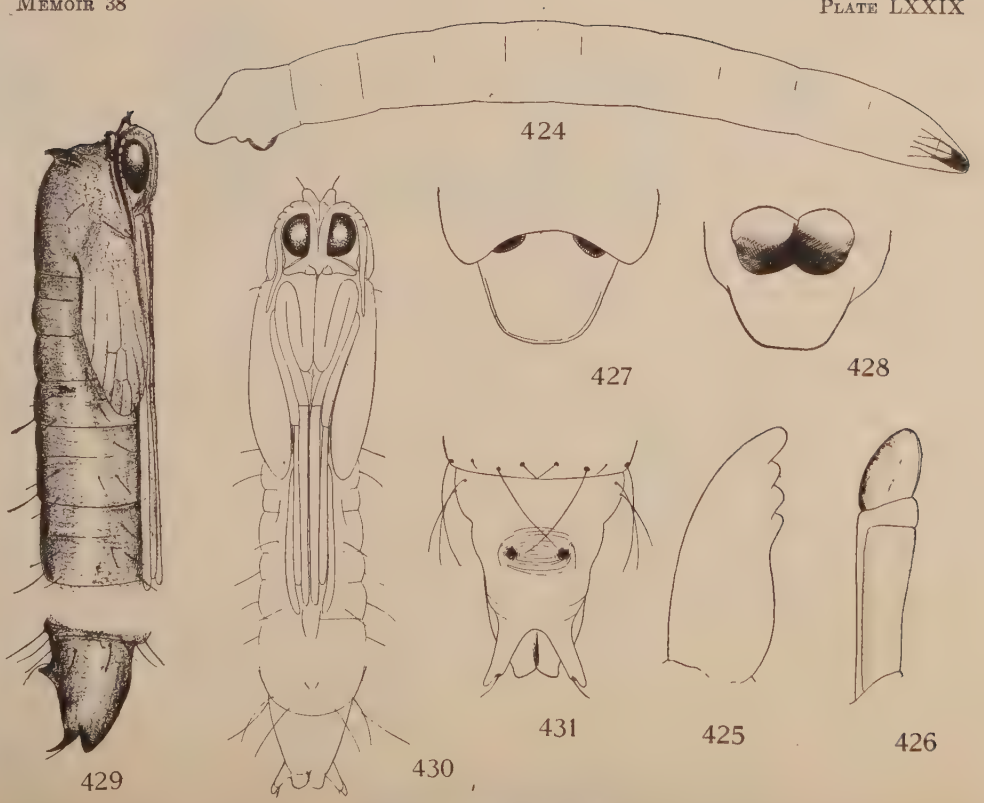
GONOMYIA SULPHURELLA AND G. KANSENSIS

Gonomyia sulphurella, pupa: 412, female, lateral aspect; 413, pronotal breathing horn, lateral aspect; 414, mouth parts
Gonomyia kansensis, pupa: 415, pronotal breathing horn, lateral aspect; 416, pronotal breathing horn, ventral aspect; 417, male cauda, dorsal aspect; 418, male cauda, lateral aspect



TRENTEPOHLIA PENNIPES AND T. BROMELIADICOLA

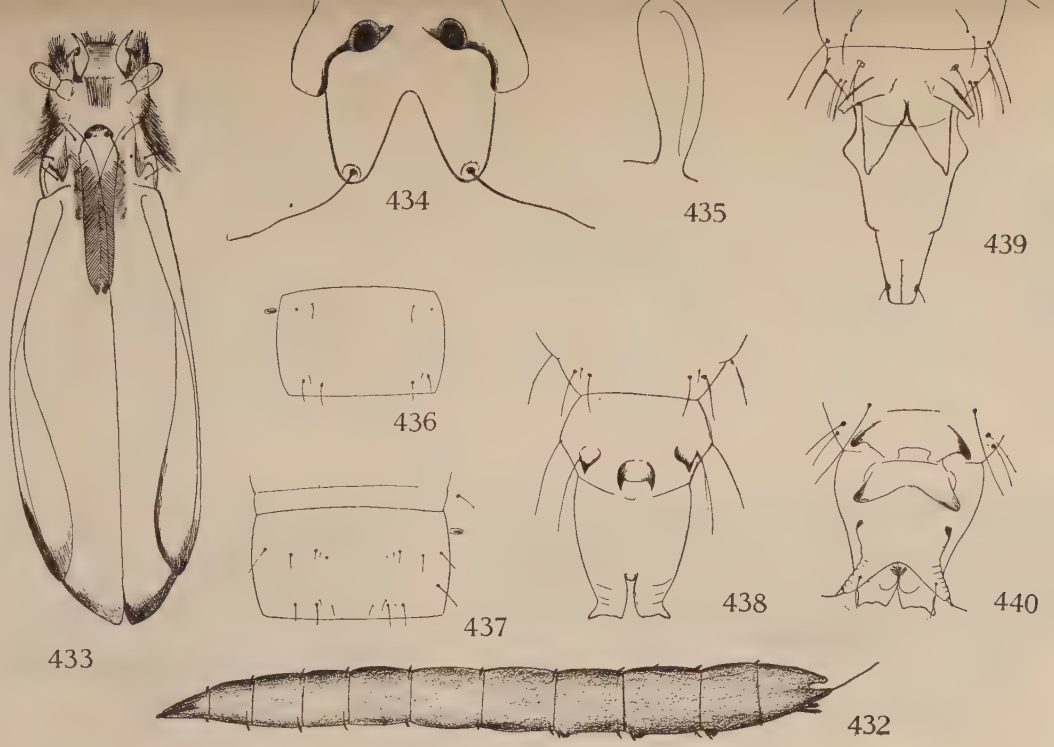
Trentepohlia pennipes, pupa: 419, lateral aspect (after De Meijere)
Trentepohlia bromeliadicola, larva (after Picado): 420, anal gills
Trentepohlia bromeliadicola, pupa (after Picado): 421, female, ventral aspect; 422, male cauda, lateral aspect; 423, female cauda, lateral aspect



TEUCHOLABIS COMPLEXA

Larva: 424, lateral aspect; 425, mandible; 426, antenna; 427, spiracular disk, dorsal aspect; 428, anal gills

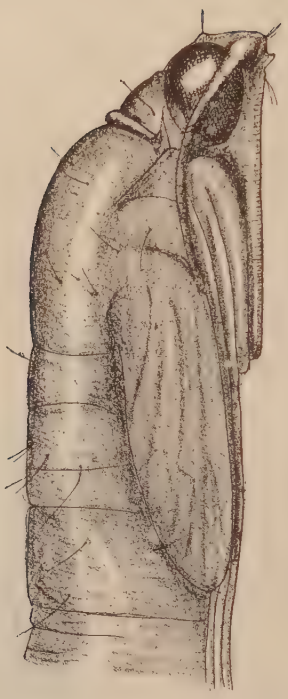
Pupa: 429, male, lateral aspect; 430, male, ventral aspect; 431, male cauda, dorsal aspect

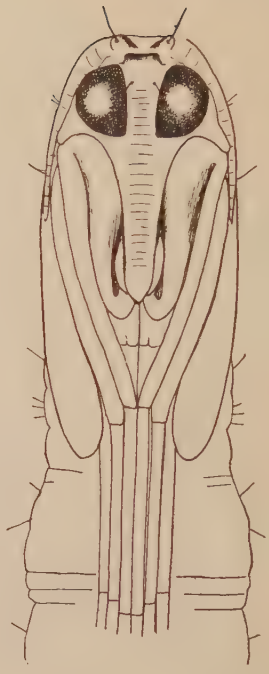


ELEPHANTOMYIA WESTWOODI

Larva: 432, lateral aspect; 433, head capsule, ventral aspect; 434, spiracular disk, dorsal aspect

Pupa: 435, pronotal breathing horn; 436, fifth abdominal segment, ventral aspect (diagrammatic); 437, fifth abdominal segment, dorsal aspect; 438, male cauda, ventral aspect; 439, female cauda, dorsal aspect; 440, male cauda, dorsal aspect





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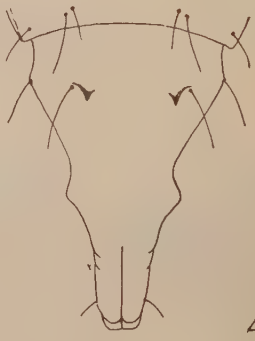
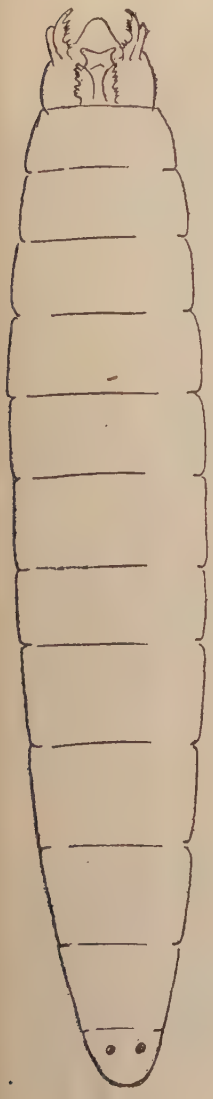


442

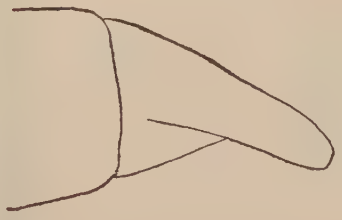
ELEPHANTOMYIA WESTWOODI, PUPA

441, Female, lateral aspect; 442, female, ventral aspect



443

444 445

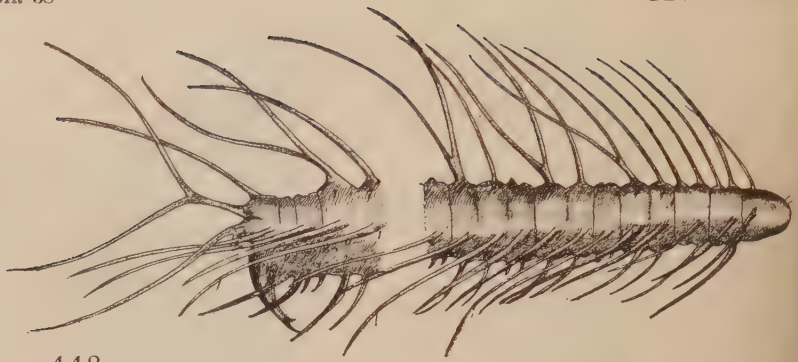


446

447

CHIONEA ARANEOIDES, LARVA (AFTER BRAUER)

443, Dorsal aspect; 444, mandible; 445, possibly mental plate; 446, spiracular disk, lateral aspect; 447, spiracular disk, dorsal aspect



448

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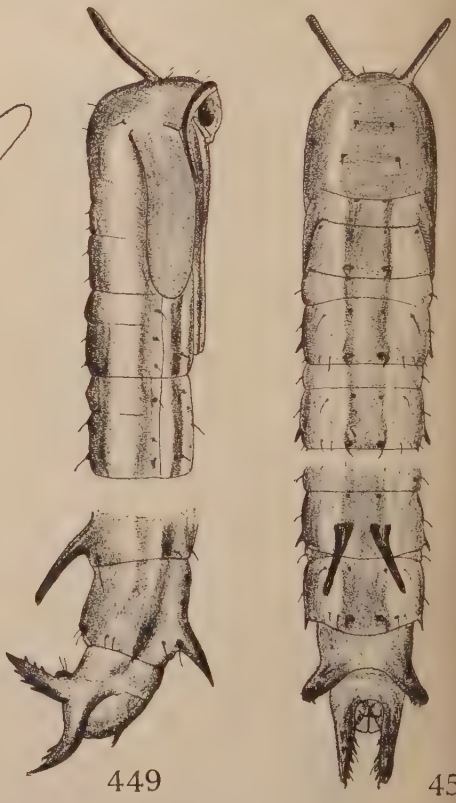

449 450

PHALACROCERA REPLICATA AND TRIOGMA TRISULCATA

Phalacrocera replicata, larva: 448, lateral aspect
Phalacrocera replicata, pupa: 449, male, lateral aspect; 450, male, dorsal aspect; 451, mouth parts
Triogma trisulcata: 452, larva (after Steinmann)

454

453

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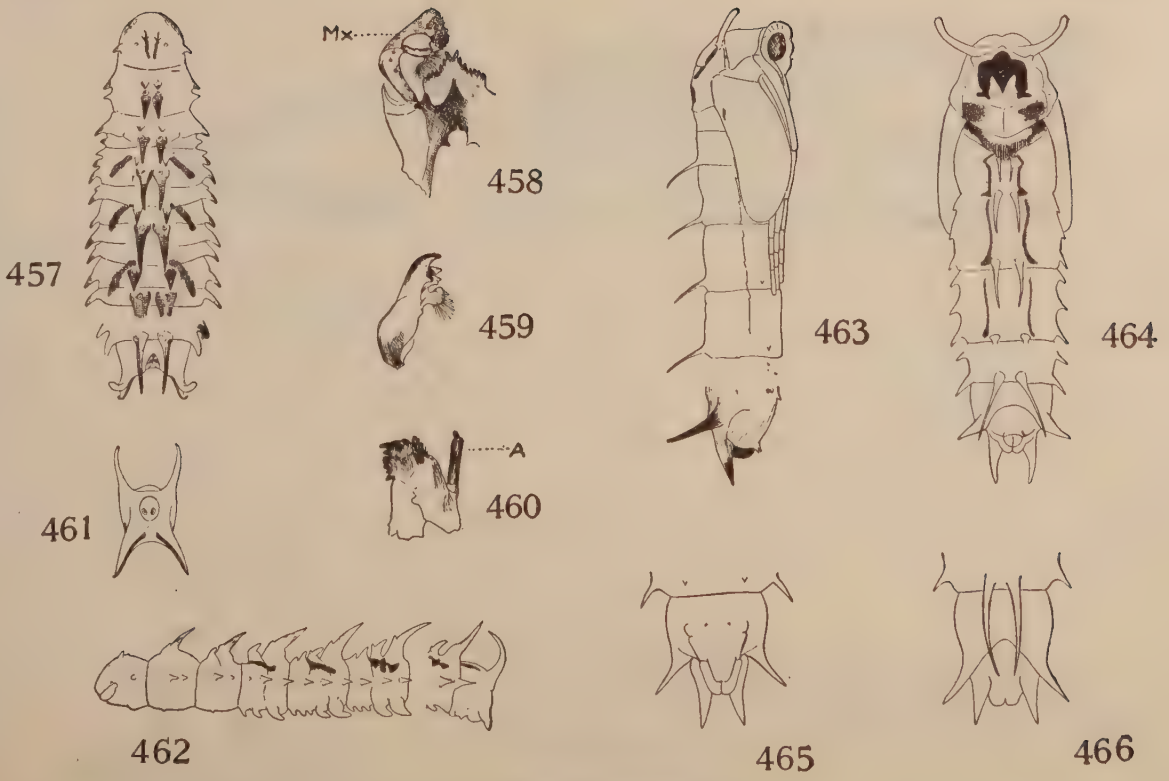
455

CYLINDROTOMA SPLENDENS

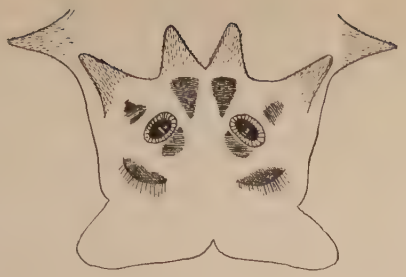
Larva: 453, dorsal aspect; 454, mandible
Pupa: 455, female, lateral aspect; 456, head of female, ventral aspect



LIOGMA NODICORNIS

Larva: 457, dorsal aspect; 458, mentum and maxilla; 459, mandible; 460, mandible and antenna; 461, spiracular disk; 462, lateral aspect of larva

Pupa: 463, male, lateral aspect; 464, male, dorsal aspect; 465, female cauda, ventral aspect; 466, female cauda, dorsal aspect



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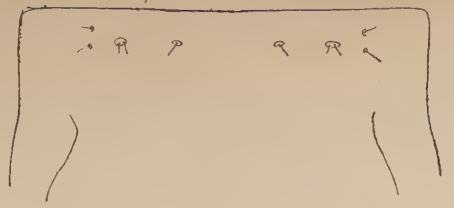

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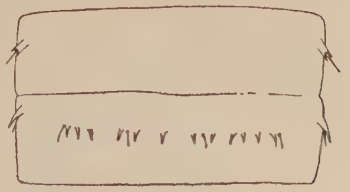

471

467

468

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473

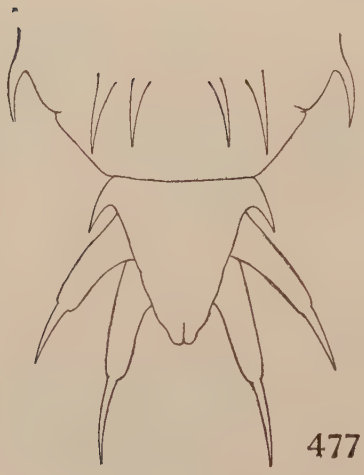
OROPEZA OBSCURA

Larva: 467, mentum; 468, hypopharynx; 469, spiracular disk

Pupa: 470, metanotum (diagrammatic); 471, fifth abdominal tergite (diagrammatic); 472, female cauda, dorsal aspect; 473, female cauda, ventral aspect

474

475

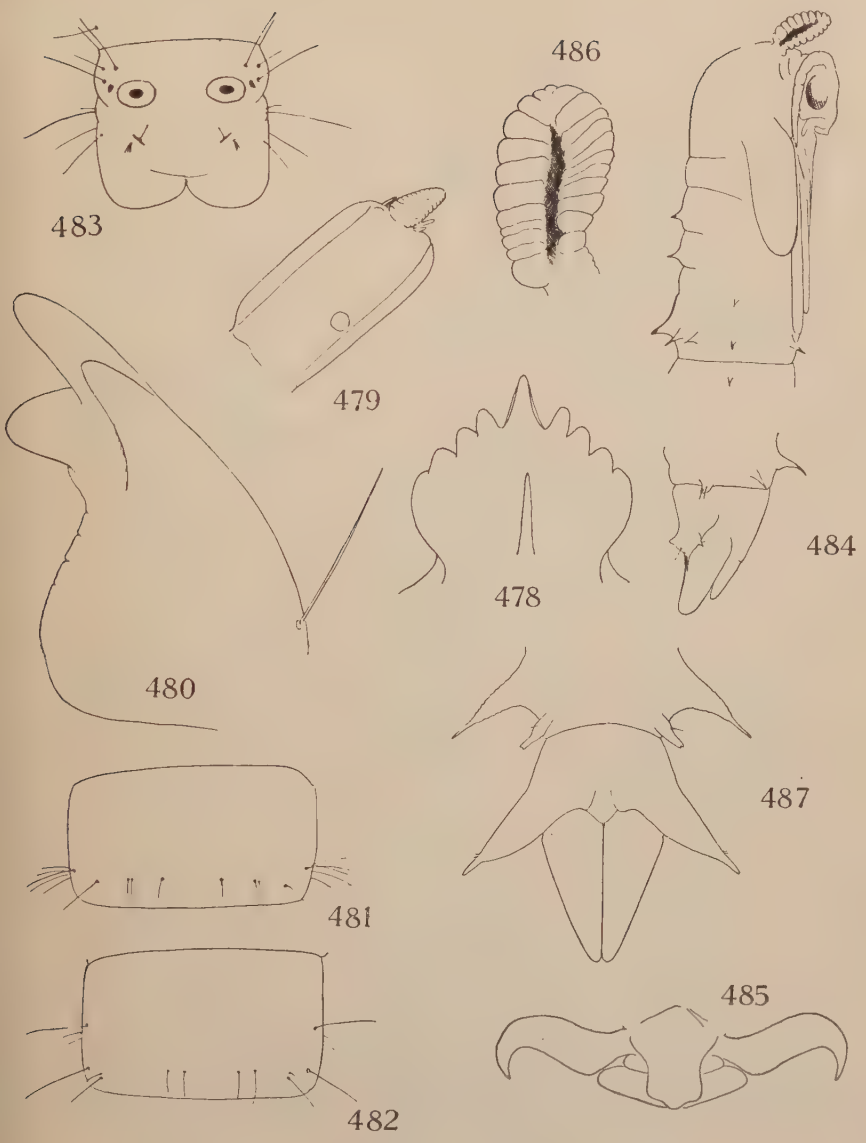


477

476

BRACHYPREMNA DISPELLENS, PUPA

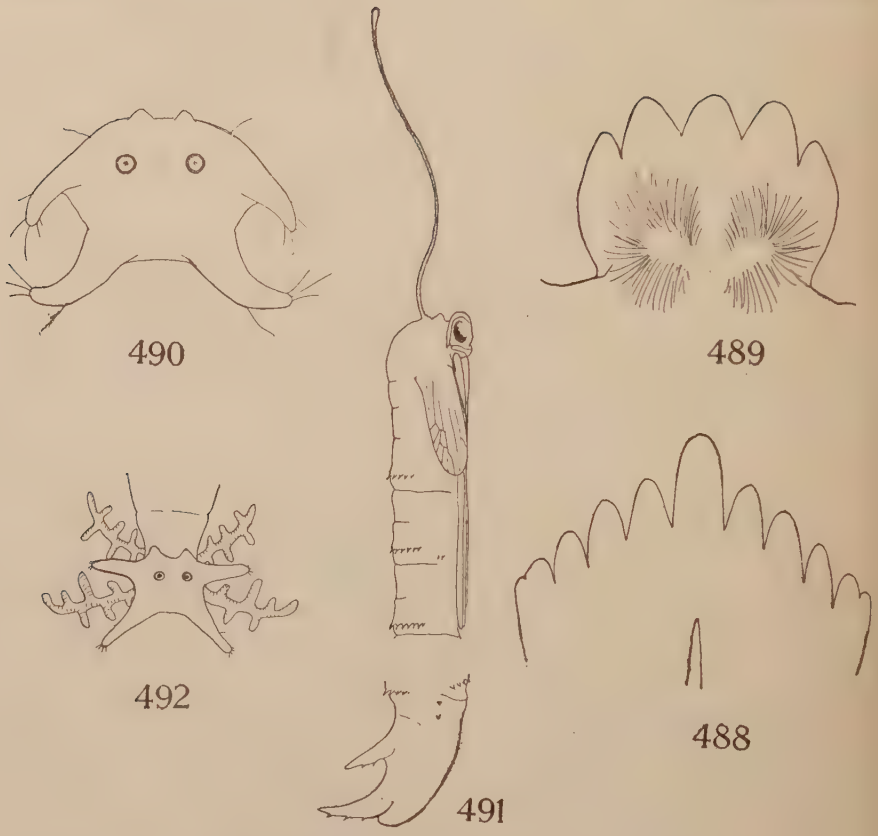
474, Head, ventral aspect; 475, pronotal breathing horn; 476, arrangement of leg sheaths; 477, male cauda, ventral aspect



TANYPTERA FRONTALIS

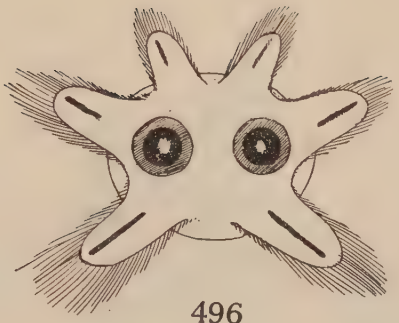
Larva: 478, mentum; 479, antenna; 480, mandible; 481, fifth abdominal segment, dorsal aspect (diagrammatic); 482, fifth abdominal segment, ventral aspect (diagrammatic); 483, spiracular disk

Pupa: 484, female, lateral aspect; 485, mouth parts; 486, pronotal breathing horn; 487, female cauda, dorsal aspect



LONGURIO TESTACEUS AND AESHNASOMA RIVERTONENSIS

Longurio testaceus, larva: 488, mentum; 489, hypopharynx; 490, spiracular disk
Longurio testaceus, pupa: 491, male, lateral aspect
Aeshnasoma rivertonensis, larva: 492, spiracular disk, showing branched anal gills (after Johnson)



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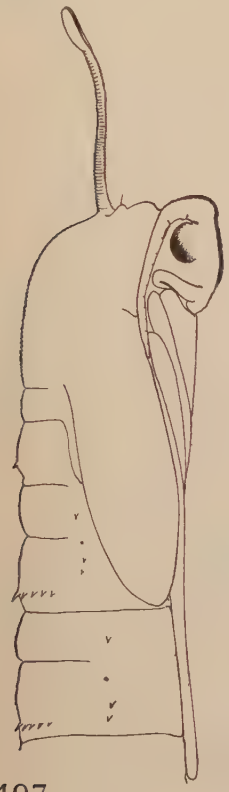

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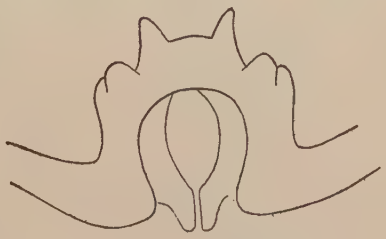
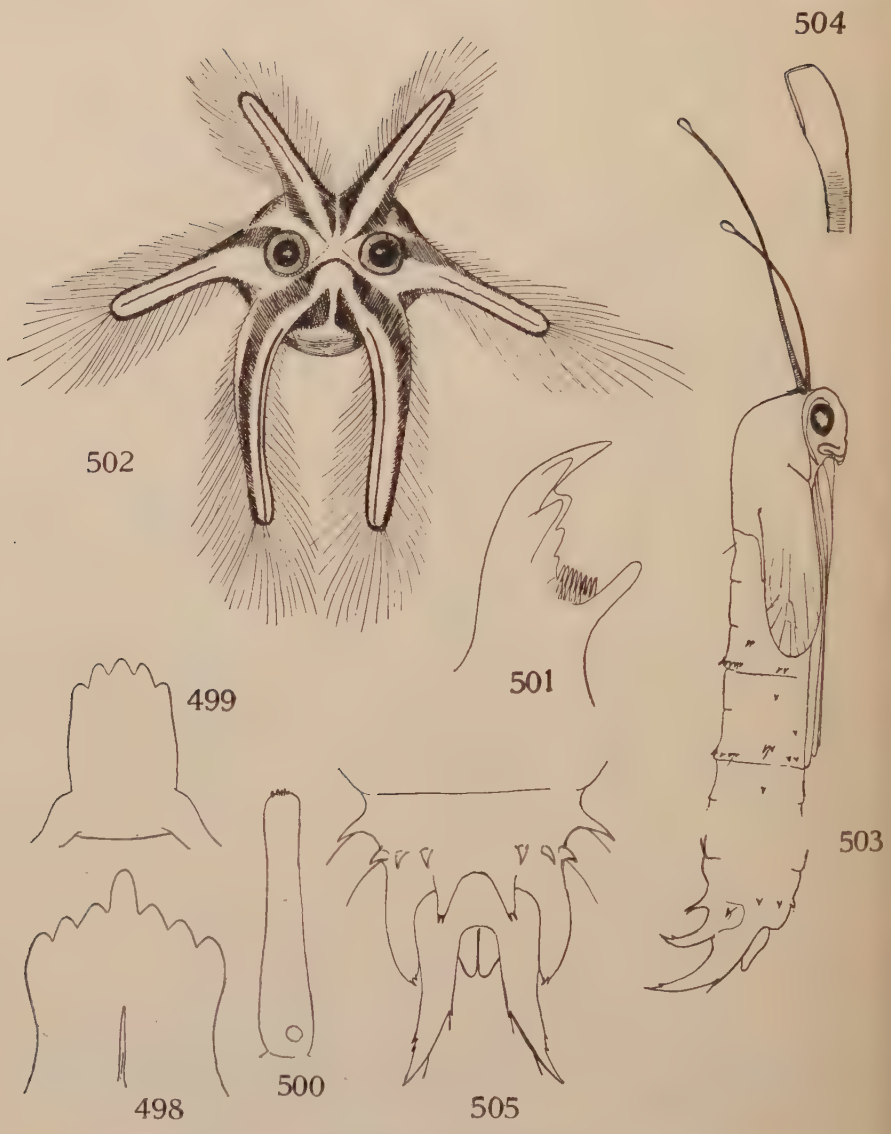


494

HOLORUSIA RUBIGINOSA

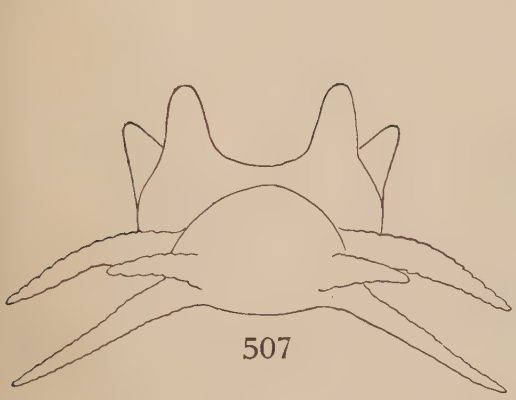
Larva: 493, mentum; 494, hypopharynx; 495, antenna; 496, spiracular disk
Pupa: 497, male, lateral aspect



PRIONOCERA FUSCIPENNIS

Larva: 498, mentum; 499, hypopharynx; 500, antenna; 501, mandible; 502, spiracular disk

Pupa: 503, lateral aspect; 504, tip of pronotal breathing horn; 505, male cauda, dorsal aspect



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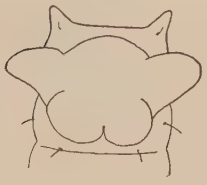

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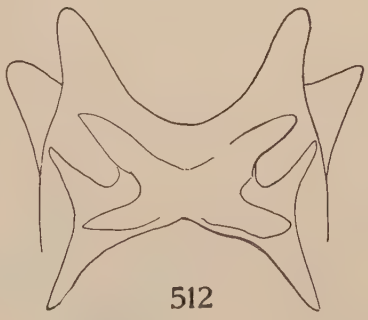

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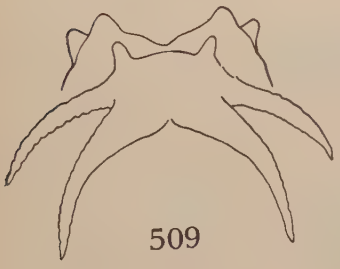
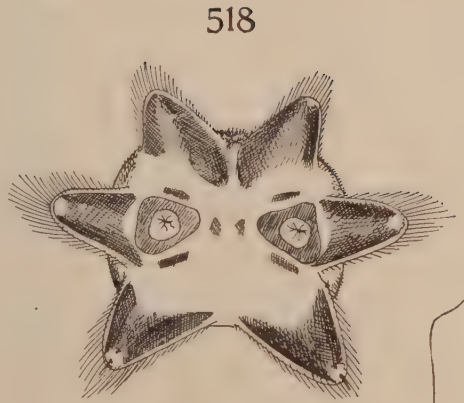


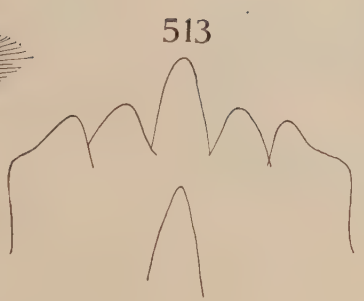
509

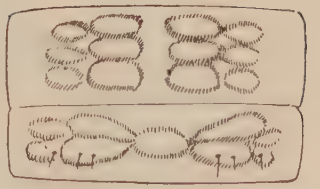
511

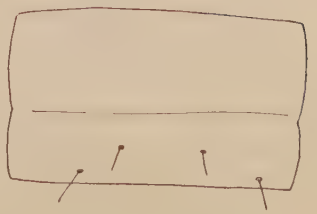
TYPES OF ANAL GILLS IN GENUS TIPULA, VENTRAL ASPECT

506, *Tipula oropezoides*; 507, *T. nobilis*; 508, *T. caloptera*; 509, *T. dejecta*; 510, *T. usitata*; 511, *T. ignobilis*; 512, *T. iroquois* (supposition)





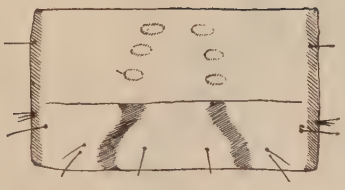




TIPULA OROPEZOIDES, LARVA

513, Mentum; 514, hypopharynx; 515, mandible; 516, fifth abdominal segment, dorsal aspect; 517, fifth abdominal segment, ventral aspect; 518, spiracular disk

520



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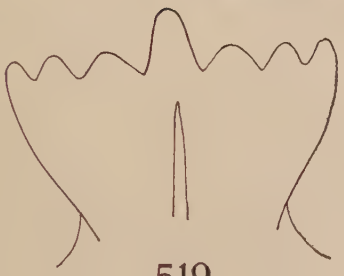

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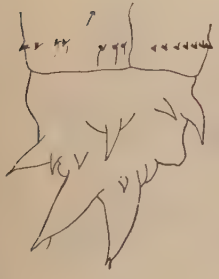

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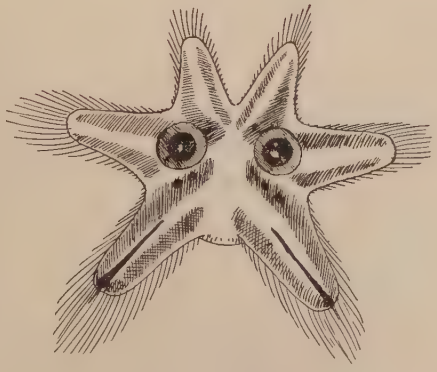
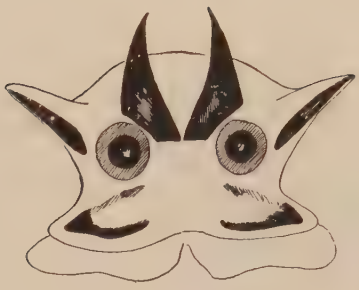


522

TIPULA COLLARIS

Larva: 519, mentum; 520, hypopharynx; 521, fifth abdominal segment, dorsal aspect; 522, spiracular disk

Pupa: 523, male, lateral aspect



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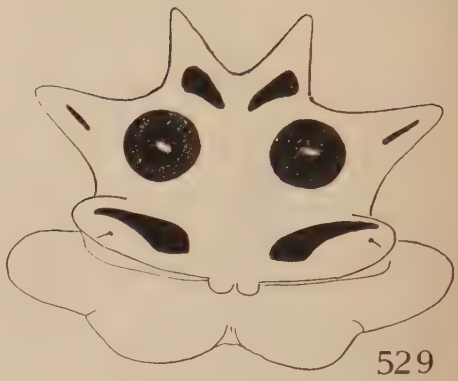

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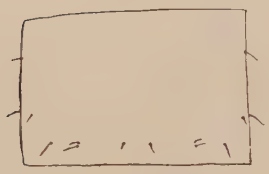

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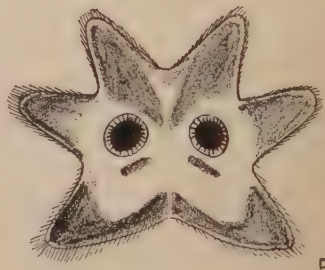
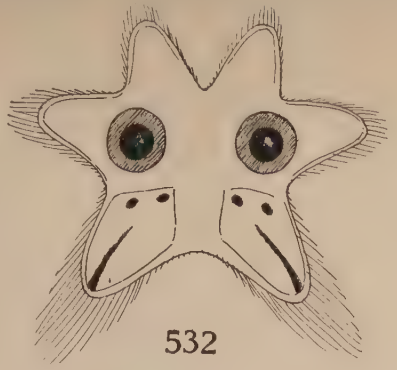
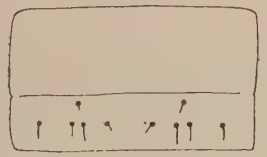


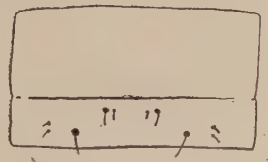
526

TIPULA DEJECTA, T. USITATA, AND T. TRIVITTATA

Tipula dejecta, larva: 524, mentum; 525, hypopharynx; 526, spiracular disk
Tipula usitata, larva: 527, fifth abdominal segment, dorsal aspect; 528, spiracular disk
Tipula trivittata, larva: 529, spiracular disk



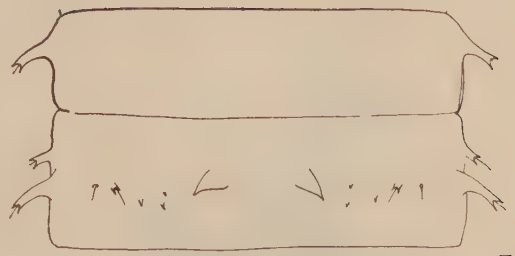




TIPULA IGNOBILIS AND TIPULINE NO. 2

Tipula ignobilis, larva: 530, fifth abdominal segment, dorsal aspect; 531, fifth abdominal segment, ventral aspect; 532, spiracular disk
Tipula ignobilis, pupa: 533; female cauda, dorsal aspect
Tipuline No. 2, larva: 534, fifth abdominal segment, dorsal aspect; 535, spiracular disk

537



538

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539

TIPULA ABDOMINALIS

Larva: 536, mentum; 537, spiracular disk
Pupa: 538, fifth abdominal tergite; 539, fifth abdominal sternite

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